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Eleven Papers on—

Capital Outlay Evaluation

and

Other Aspects of Return on Investment

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Contrast Between Financial-Statement and Discounted-Cash-Flow Methods of Comparing Projects

by JOHN W. COUGHLAN

To JUDGE from the great number of articles on return on investment that have appeared in recent months, interest is at an all-time high. There are, however, two different ways to compute return on investment, and each of these has a substantial following. One of these methods is the financial-statement method and the other is the discounted-cash-flow method. Division managers and plant managers, indeed everyone entrusted with the use of financial resources and expected to earn a return on them, will find it worth their time to study the nature of both methods; while the discounted-cash-flow method indicates which alternatives are best for the company, the financial-statement method is much more widely used to appraise performance.

The Two Methods

Financial-statement method. This method has also been referred to as the accountant's method and the book-value method. According to this method, the rate of return on investment is the ratio of the income of the business as determined by the income statement to the investment as shown on the balance sheet. Quite naturally, it is the method most popular with accountants, since it is based on the financial statements which are a product of the accounting process. A simple illustration of this method is presented below:

	Year 1	*Year 2*
1. Net income before deducting depreciation	$ 576.19	$ 576.19
2. Depreciation	500.00	500.00
3. Net income	$ 76.19	$ 76.19
4. Investment	1,000.00	1,000.00
5. Return on investment (line 3 ÷ line 4)	7.6%	7.6%

Here it is assumed that a company buys a depreciable asset with a two-year

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life expectancy and a cost of $1,000. All sales are for cash and all expenses, except depreciation, involve an outlay of cash in the same period as the expenses are recognized for accounting purposes.

Discounted-cash-flow method. According to the discounted-cash-flow method, the return on investment is that interest rate which, if used to discount the cash inflows back to the date of the initial investment, would equate the sum of these discounted cash flows to the cash outflow occurring at the time of the initial investment. In other words, it is i in this equation:

$$C = R_1/(1+i) + R_2/(1+i)^2 + R_3/(1+i)^3 + \ldots R_n/(1+i)^n$$

where C is the original cost of the investment, R_1 the cash inflow from the investment in year 1, R_2 the cash inflow from the investment in year 2 and R_n the cash inflow from the investment in the year n.

The discounted-cash-flow method may be illustrated by use of the same figures as the financial-statement method and it will be found that an interest rate of ten percent equates the cash inflows and the cash outflows if they are all discounted or accumulated by this interest rate to the same reference date. To simplify the arithmetic, it has been assumed that the cash inflows all occur at the end of the year. (Usually, as in the above definition and equation, the reference date is the date of the initial investment as this obviates the necessity of discounting or accumulating the initial investment.) Another way of looking at the discounted-cash-flow method is that it gives the interest rate which, if applied to the investment, will cause the interest plus the initial investment to amount to the total cash inflows. In other words, the cash inflows in the present case repay the original investment of $1,000 and yield a return of ten percent of the amount of investment not repaid at the beginning of each year, as illustrated below:

	Year 1	*Year 2*
Investment at beginning of year	$1,000.00	$523.81
Interest earned during year (10%)	100.00	52.38
Investment and interest	$1,100.00	$576.19
Net cash inflow	576.19	576.19
Investment at end of year	$ 523.81	$ 0

Both the financial-statement and the discounted-cash-flow methods yield a net return of $152.38 over the two years, but they distribute it differently. They result in a very different return on investment, with the financial-statement method indicating a 7.6 percent return in each year and the discounted-cash-flow method indicating a return of 10 percent a year, over the two-year period.

Different Context of the Methods

The financial-statement method has been primarily employed for the appraisal of past performance whereas the discounted-cash-flow method has been most commonly employed in capital budgeting. It is quite natural that the financial-statement method should emphasize the past, since the balance sheet and income statement purport to be objective records of past performance.

In contrast, a recent study of the N.A.A. (N.A.A. Research Report No. 35, *"Return on Capital as a Guide to Managerial Decisions,"* New York, 1959) revealed the interesting fact that the discounted-cash-flow method was not nearly as widely employed as the frequent discussion in the business journals would suggest. Nevertheless, where it was employed by the companies surveyed, its use was invariably in the field of capital budgeting, that is, deciding whether to purchase new machinery, replace old machinery, and so on. From these circumstances, it might possibly be inferred that the correct sphere of influence of the financial-statement method is the appraisal of past performance, whereas the discounted-cash-flow method is primarily useful for planning for the future. However, any such attempt to relate one method (the financial-statement method) to the past, and the other (the discounted-cash-flow method) to the future is poorly founded. Both purport to disclose the effectiveness with which resources are employed; whether such employment is in the past or the future makes no difference. If one method discloses the most effective use for financial resources in the future, when that future comes the same method should be employed to disclose how effectively the resources have, in fact, been employed. The folly of using one method for the future and another for the past may be illustrated in terms of the previous illustration. Had the discounted-cash-flow method been employed for capital-budgeting purposes, the company would have anticipated a ten percent return on the project. Had it then proceeded with the project and entrusted it to a project manager, it would have been very foolish to employ the financial-statement method to appraise his performance. If the project manager realized exactly the potential of the project as determined in the capital-budgeting study, the financial-statement method would have assigned only a 7.6 percent return on investment, and his superiors would have had to berate him for not realizing the ten percent potential the capital-budgeting study had indicated was possible! Whatever method is appropriate for making decisions about the future is also suitable for appraising the past. The N.A.A. study indicated considerable awareness of this consideration. Many companies prevented any inconsistency between their methods by using the financial-statement method both for capital budgeting and for appraising performance (*Ibid.*, Chapter 10.)

The Financial-Statement Method and Accounting Assumptions

Despite its popularity, it is the financial-statement method that is least useful for making decisions about the past and for appraising performance. The defects of the financial-statement method arise from certain basic assumptions of contemporary accounting. These are:

1. The fiscal-periods hypothesis.
2. The absence of time as an influence on financial statements.
3. The hidden assumption of accounting that the return, i.e., the net income of a particular year, relates to an entirely different investment than that used in the financial-statement method.

Each of these assumptions is discussed below.

The fiscal-periods hypothesis. The accountant has a difficult problem during the lifetime of a project. He does not know what the total income of the project will be until the project has come to an end and has been abandoned. In the meantime, however, management wants interim soundings. The accountant has two basic possibilities before him; he can present periodic reports giving an increasingly accurate measurement of the total income from a particular venture or he can attempt to determine, as objectively as possible, the amount of income that has been earned during a particular year. Contemporary accounting is based in the latter attempt.

The fiscal-periods hypothesis has two unfortunate consequences for the financial-statement method. First, the financial-statement method reports as many rates of return as there are arbitrary calendar periods (years, quarters, months) to which the accountant allocates portions of the over-all income on the project. Thus for the project previously discussed, there was only one rate of return, ten percent, according to the discounted-cash-flow method, but there were two rates of return, both of them 7.6 percent, according to the financial-statement method. In our simple example, the rate of return was the same in both years for the financial-statement method. In a more complex case, difficulties would arise if the rates of return as reported by the financial-statement method were not the same in the different periods. Suppose, for example, the board of directors says no projects shall be included in the financial budget unless they promise a return on investment of more than ten percent. What is management to do if a particular project offers a return—as measured by the financial-statement method—of thirteen percent in the first six years of its operations and a return of six percent in the last four years? Must it be rejected because the rate of return falls below the board's objective of ten percent in the last four years,

or should some attempt be made to average the rates of return earned in the various years? No such problem arises in the case of the discounted-cash-flow method because only one rate of return on investment is computed and the period underlying this rate of return figure is the same period as that underlying the decision on the project, namely, the life of the project.

Second, due to diversity of accounting methods, the rate of return computed on a period basis is completely at the mercy of the accountant. Anyone who has struggled with the problems of inventory pricing or of depreciating fixed assets knows that rate of return on investment in a particular year depends as much on the accounting methods followed as it does on the over-all performance of management. In contrast, the discounted-cash-flow method attempts to compute income for the over-all life of the project; it bases its computation on the total income from the project or on the latest estimate of the total income; it does not depend in any way on the allocation of revenue and expense to arbitrary calendar periods; it is affected by varying estimates of the amounts of future revenues and expenses but not by the differing methods of allocating revenues and expenses that have supposedly been realized or incurred.

Time and accounting. In modern business, the time for which the money will be tied up in a project is of the essence. Curiously enough, accounting ignores time. It is true that the accountant dates his balance sheet and specifies the period covered by his income statement. But there is no introduction of time into modern financial statements in such a way as to inform the reader how long money was tied up in a particular investment before income was realized. Such an introduction of time might occur in two ways:

1. Major classifications on the income statement and the balance sheet stated by time periods. Thus, on the income statement, instead of showing the breakdown of expenses into salaries, cost of goods sold and depreciation, the breakdown might be by expenditures incurred in 1959, expenditures incurred in 1958, expenditures incurred in 1957 and so on. Such a breakdown would permit the reader of financial statements to compute the return earned on the over-all investment by relating the period the money was tied up in the project to the amount of return eventually realized. Such a classification of expenditures and receipts would permit the "do-it-yourself" reader of financial statements to introduce the time factor into his computation of return on investment.
2. By increasing those expenses that had been incurred long in the past by the introduction of an implicit interest factor. Imagine a project having no expense other than a depreciation charge. The depreciation charge might be increased considerably if the purchase

of the depreciable asset had occurred many years in the past. This use of an implicit interest factor would recognize the fact that the return on an investment is less if the money is tied up in the investment for a longer period of time.

Since time is absent from the accounting process, it is also absent from any rate of return calculation that relies on financial statements. The investor who subscribes to the superiority of today's dollar over tomorrow's dollar should be well aware of this limitation of the financial-statement method.

Identity of the investment base. A further defect of the financial-statement method arises from a basic conflict between it and the financial statements on which it is based. This conflict results from the assumptions the accountant must make in allocating income to arbitrary periods of time, the fiscal-periods hypothesis previously discussed. If so much of the income from a project is to be reported in a particular year, then some of the revenues and some of the costs also must be assigned to that period. This allocation of cost is particularly difficult for inventory, various types of deferred charges, and depreciable assets. Let us concentrate here on depreciable assets. The assignment of a portion of the cost of a depreciable asset to a particular year is done by means of the depreciation charge. While depreciation means different things to different people, accountants are quite insistent that depreciation is a process of allocation, not of valuation.

The difference between the investor and the accountant is that the investor, in making a decision about a proposed project, relates all expected revenues from the project to the initial investment, whereas the accountant, in reporting income, relates portions of the initial investment to the revenues of the various years. This accounting process of allocation considers the depreciation charge as the cost of the services of the machine received during the period. The initial investment in the machine is considered to be equivalent to the purchase of several years' services of that machine, and the depreciation charge is the allocation to a particular year of the cost of the services purchased for the benefit of that year.

Following this interpretation, the financial-statement method is inconsistent with the very assumptions on which depreciation accounting is based. If a portion of the original investment in the machine is related to the services of the current year, then the rate of return on investment is the relationship between the profit for the year and the current depreciation charge. It is not, as currently computed, the relationship between net income after depreciation to the total cost of the depreciable asset including those portions of the cost applicable to other years.

Consider the calculation of rate of return on investment for the project in the previous illustration. Using the financial-statement method, the return during the first year is $76.19, giving a 7.6 percent rate of return on the investment of $1,000. This investment included both the amount considered applicable to the current year (the current depreciation of $500) and, also, the amount that would be amortized in the following year (the $500 depreciation charge of the second year). If one really wanted to compute rate of return by means of the products of the accounting process, one should relate income to the depreciation charge, as shown in the following equation: $500\ (1+i) = 576.19$, where i is the rate of return on investment. In other words, the rate of return on investment—$i = .1524$. Similarly, the rate of return on the $500 investment relating to the income of the second year $= 500\ (1+i)^2 = 576.19$, that is, $i = .0735$. In the latter case, the return-on-investment factor was squared since this was the rate of return for an investment of $500 for two years.

It might be argued that, in the first year, surely there is some income applicable to the investment not yet amortized and, accordingly, it makes good sense to use the total investment in the depreciable asset as the investment base for the income realized in the first year. Surely some of the income to be received in subsequent years has been earned during the current year. Traditional accounting, however, applies a realization criterion stating that no income has been earned until realized through sale. Therefore, the income relating to the unamortized cost of the depreciable assets will not be recognized until the services of that depreciable asset have resulted in sales. So, even though the investment base in the usual financial-statement method of computing rate of return relates to the services to be derived from the assets in future years, no part of that income is currently recognized for accounting purposes.

Differing Influences upon Choice of Project

Plant and division managers should know something about the computation of rate of return, since it affects their choice about what projects to undertake. A plant manager interested in the maximum prosperity of the company should use the discounted-cash-flow method since he will find that this method tells which of two projects will give the largest accumulation of resources to the company over a given period of time. He should compute also the prospective rate of return according to the financial-statement method because his performance in handling the project will almost certainly be appraised by the financial-statement method. He may find, and this is a disturbing prospect, that the project which is best for the company (discounted-cash-flow method) is the one that will give him the lowest rate of return on investment (financial-statement method).

Use of the Two Methods in Choosing Between Projects

		Project A	Project B	Project C
Investment at beginning of year 1		$1,000	$1,000	$1,000
Investment at beginning of year 3		1,000		
Cash inflows at end of year:	Year 1	576.19	322	315.47
	Year 2	576.19	322	315.47
	Year 3	576.19	322	315.47
	Year 4	576.19	322	315.47
Total cash at end of year 4 if cash inflows are reinvested at 10% per year		1,464.10	1,494.40	1,464.10
Rate of return according to:				
Discounted-cash-flow method		10%	11%	10%
Financial-statement method		7.6%	7.2%	6.5%

EXHIBIT 1

Consider Projects A and B in Exhibit 1. Project B requires an initial investment of $1,000 and results in cash inflows of $322 per year for the following four years. Project A is the project discussed in the previous illustrations. To make it comparable to the four-year life-span of Project B, it is assumed that a second investment in Project A is made at the beginning of the third year, so that the cash inflows of $576.19 will continue for four years. Let the "best" project be the project that results in the largest accumulation of assets by the end of the life of the projects. The cash flows themselves are not enough, however, to determine what the total accumulation of assets will be by the end of the fourth year; a "reinvestment rate" must also be assumed. This reinvestment rate is the rate of interest earned on the cash inflows from the time they are received until the end of the fourth year. Assuming a reinvestment rate of ten percent, the accumulations of cash by the end of the fourth year will be $1,464.10 for Project A and $1,494.40 for Project B. In other words, if Project A is chosen, the company will have $464.10 more than its original investment of $1,000 at the end of the fourth year, whereas it will have $494.40 more if Project B is chosen. Clearly Project B is superior, although, it should be noted, the results depend, in part, on the reinvestment rate. If the company were only able to earn four percent, or less, on its reinvested cash proceeds, then Project A would be the better project. This consideration does not indicate any defect in the ensuing remarks about the use of the discounted-cash-flow method. This method always assigns the highest rate of return on investment to the project giving the largest accumu-

lation of cash at the end of the investment period provided not only the cash inflows from the project are discounted but also the interest earnings are discounted as part of the process of determining the rate of return. This discounting of the interest earnings on the cash inflows from the project is necessary where, as here, the cash inflows from the projects compared cover different periods of time. In the following analysis, to keep the arithmetic simple, the interest earnings have been ignored in determining the rate of return.

The results of the discounted-cash-flow method are in agreement about the superiority of Project B. Not so the financial-statement method which asserts that the return is higher for Project A (7.6%) than for Project B (7.2%). Why did Project B, giving the greatest accumulation of assets to the company, show a lower rate of return by the financial-statement method than Project A? As previously pointed out, the financial-statement method uses the wrong investment base—an investment base other than that assumed by the usual accounting process. Had the net income of Project A been related to $500 depreciation charge in each year and had the net income of Project B been related to the $250 depreciation charge in each year, the return on investment for Project B would have been higher in all years. However, the net income of Project A was related to an investment base pertaining to the operations of two years whereas the net income of Project B was related to an investment base pertaining to four years. Both investment bases were inflated, but the investment base for Project B was the more seriously inflated.

It is evident from this illustration that the financial-statement method favors projects having a short life-span. The net income of projects having a longer life-span is divided by an investment figure for that longer period. This defect of the financial-statement method may be further illustrated by Projects A and C of Exhibit 1. Both these projects result in the same total accumulation of cash ($1,464.10) at the end of the fourth year and both earn the same return on investment, according to the discounted-cash-flow method. According to the financial-statement method, however, Project A earns a 7.6 percent return on investment and this appears to be superior to the 6.5 percent earned by Project C. The reason for this false appearance of superiority for Project A is that the net income of this project is compared with an investment base relating to the earnings of only two years, whereas the net income of Project B must show a suitable return on an investment base relating to the operations of four years.

Why is it that a project with a one-year life and a project with an indefinitely long life have the same rate of return on investment for both the financial-statement method and the discounted-cash-flow method? The reason becomes clear when it is remembered that the accounting process relates the income of a

particular year to the depreciation charge of that year and the financial-statement method then relates the income to the over-all investment in the project. If the project has a one-year life, the amount of the depreciation charge and the total investment base are identical; in this case, the financial-statement method is not inflating the investment base by using the total investment in the project since all of this investment is related to the income of that year. As the length of the project increases beyond a certain intermediate point, the conflict between deducting a depreciation charge and then relating the net income to a different investment, the over-all investment in the project, gradually disappears. After a certain point, the depreciation charge sinks to insignificance. For a project with an indefinitely long life, the depreciation charge is negligible, the conflict between the deduction of a depreciation charge and the computation of the financial-statement rate of return on the total investment base disappears wih the disappearance of the depreciation charge, and a unanimity between the financial-statement method and the discounted-cash-flow method is restored. In between these limits, projects are penalized through deducting a depreciation charge and then relating the net income to the total investment including the investment relating to the income from all the other years of the project.

Letting k_f represent rate of return according to the financial-statement method and k_d represent rate of return according to the discounted-cash-flow method, then

$$k_f = \frac{R - C/N}{C} = R/C - 1/N$$

and

$$k_d = R/C - R/C\ (1/1 + k_d)^N$$

where C represents cost of the asset
R represents the annual cash inflow
and N represents the life of the asset

It will be seen that k_d exceeds k_f as long as $1/N$ is greater than $R/C\ (1/1+ k_d)^N$. When $N = 1$ and when $N =$ infinity, the two rate of return figures are identical.

Financial-Statement Method No Better on Net Asset Base

Many companies, in computing rate of return on investment by the financial-statement method, do not use the "gross" investment in the depreciable assets but, rather, the cost of the depreciable asset less the accumulated allowances for depreciation. If cost less allowances for depreciation is the investment base, then again there is no assurance that the manager's self-interest will encourage him to undertake the project most favorable to the company. The rate of return on investment for Projects A and B is summarized in Exhibit 2 on the assumption that the allowances for depreciation are deducted in computing the

investment base. It is assumed that the balance of the investment at the beginning of the year is used as the investment base. Thus, for both projects, the investment base at the beginning of the first year is $1,000. At the beginning of the second year, a $500 allowance for depreciation is deducted from the cost of the depreciable asset in Project A so that the net investment base is only $500. For Project B, the investment base at the beginning of year 2 is $750, since the depreciation charge during the first year was only $250 for this project. The other investment figures are computed in the same manner. In the first and second years, a higher rate of return on investment will be reported for Project A than for Project B, with Project B having a higher rate of return during the third and fourth years. Which pattern will make the plant manager look best depends in part on his own plans and expectations. Thus, for instance, if he hopes to receive a promotion within the next two years, he might be well advised to choose Project A as this will give him a higher rate of return in the first two years and will, therefore, support his bid for promotion. The fact that Project B would look better in the third and fourth years has no relevance if he will have moved on to some other job and left the project to his replacement. Indeed, he may fear that unfavorable comparisons will be drawn between himself and his replacement from the upward trend of the Project B rate-of-return figures after his departure.

Use of Assets Less Accumulated Allowances for Depreciation as the Investment Base

Year	Project	Investment base at beginning of year	Net income	Return on investment
1	Project A	$1,000	$76	7.6%
	Project B	1,000	72	7.2
2	Project A	500	76	15.2
	Project B	750	72	9.6
3	Project A	1,000	76	7.6
	Project B	500	72	14.4
4	Project A	500	76	15.2
	Project B	250	72	28.8

EXHIBIT 2

These conclusions, by the way, follow whether cost less allowances for depreciation is taken at the beginning of the year or the average of the beginning and closing figures is used as the investment base. In the latter case, the return-on-investment figures are as follows:

Rate of Return on Investment

Year	*Project A*	*Project B*
1	10.1%	8.2%
2	30.4	11.5
3	10.1	19.2
4	30.4	57.6

Note that, in this case, Project A again appears superior to Project B in the first two years and Project B appears superior in the last two years. Again, there is the danger that Project A will be chosen in preference to the superior Project B.

Able arguments have been given for both gross assets as the investment base and for the use of cost less the accumulated allowances for deprecation as the investment base. Many of these arguments are based on preconceived notions about what the pattern of rate of return ought to be. Thus, those who argue for the use of gross assets as the investment base point out that, given a constant net income, rate of return will rise constantly over the life of the asset if the diminishing cost-less-allowance investment base is employed. In opposition to this argument, it has been pointed out that income tends to fall over the life of a project (obsolescence of product and machinery, more repairs and maintenance, more frequent breakdowns). With declining income, using cost less accumulated depreciation will result in a more stable rate of return (Thomas H. Casson, "Return on Investment," *The Controller,* September 1959, pp. 411-13, 436-37). Proponents of each investment base ascribe considerable importance to a stable rate of return figure over the life of the project. Perhaps this emphasis on stability of rate of return is an attempt to overcome the multiplicity of rates of return that result from the fiscal-periods hypothesis. Is the attempt to get a stable rate of return for the different years a step in the direction of getting one rate of return for a project? If so, it is doomed to failure for the fiscal-periods hypothesis will continue to produce multiple rates of return even though the method of computing rate of return is chosen in such a way as to attempt to stabilize these rates of return.

Whichever investment base is used, whether before or after deducting accumulated allowances for depreciation, it is still the financial-statement method that is being employed, and return is still being related to the wrong investment base. If the gross investment base is being employed, then the income assigned to a particular year is being related to the investment applicable to the income of all the years during the life of the project. If cost less accumulated allowances for depreciation is being employed, then the income is being related to the investment applicable to the income of the current and all future years. The latter (cost less accumulated depreciation) does have some advantages. Thus, in the

last year of a project's life, the investment base corresponds to the depreciation charge and is accordingly the investment base implied by the accounting records.

The consequence of this relationship is that even though an investment with a medium-length life may suffer from unfavorable comparisons with short-range projects during its early years, the comparison will become distinctly favorable toward the end of its life. Thus Project B which offered a higher rate of return than Project A according to the discounted-cash-flow method, always made a lower score by the financial-statement method if the gross investment base were employed. But if cost less accumulated depreciation serves as the investment base, the comparison becomes decidedly favorable for Project B toward the end of its life. (See Exhibit 2). These effects are, however, largely fortuitous. Even if cost less accumulated depreciation is used for the investment base, the financial-statement method still relates income to an investment completely foreign to the assumptions underlying the accounting process.

Conclusions

Contemporary accounting has been developed for the purpose of allocating income to arbitrary calendar periods. It was not primarily designed for the calculation of return on investment and cannot play an important role in such a calculation, except very imperfectly. Since accounting breaks the income stream into amounts assignable to arbitrary calendar periods, the use of such income will result in too many rates of return being calculated, and these rates will largely depend on the accounting methods employed. Since accounting ignores time, as a component in the appraisal, whereas time is vital both for planning the future and for evaluating the past, the financial-statement rate of return is not a reliable guide in choosing between alternatives. Finally, while the financial-statement method purports to employ the products of the accounting process, its choice of an investment base is inconsistent with the investment base implied by the accounting process.

Discounting Differential Cost in Machine Replacement — An Outline

by THOMAS N. SPAETH*

As TECHNOLOGICAL improvements occur in equipment markets, an appraisal of existing models is highly advantageous. Aside from the fact that presently operating machines may not be producing efficiently, there may be other merits in acquiring new assets. A less obvious but equally important consideration is the necessity for replacement resulting from differential costs.

In analyzing the problem of equipment replacement through differential costs, it is important to be able to recognize the costs which remain the same under two processes. This is the starting point of machine replacement analysis. While the first approach concerns the initial decision to make the replacement, assuming the change in equipment is necessary, there is a possibility that a lease program may be more advantageous than an outright purchase. Therefore, the rent-or-buy consideration may also be taken as an inherent part of replacement procedures.

The initial outlay of funds for the new equipment less the amount realized from disposal of the old is here designated as net investment, or N.I. It is likely that the new equipment will increase profits due to increased production and/or lower operating costs. This increase is here called Annual Operating Savings, or O.S. The known or expected net investment is compared with the known or expected annual operating savings in order to justify or deny a purchase. The following example will serve to illustrate net investment and annual operating savings:

Machine B has a purchase price of $60,000. Machine A, currently in use, has a salvage value of $7,500. Therefore, the N.I. is $60,000 minus $7,500 or $52,500. O.S. can be derived from the schedule below:

Annual Costs	*Machine A*	*Machine B*	*Annual Operating Savings*
Labor	25,000	15,000	10,000
Power	1,000	1,000	– 0 –
Maintenance	1,000	500	500
Totals	27,000	16,500	10,500

The preceding schedule is based on the annual expected increase in operating savings. Granting that O.S. will remain the same throughout the useful life of the new machine, expected future savings are not equal,

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dollar for dollar, with present savings. Therefore, it is necessary to discount the sum of future annual operating savings to their present value.

Applying this concept to the illustration and assuming that the savings will continue for ten years, the cumulative present value of O.S. can be computed. It is also assumed that a 10-percent rate of return is required. In other words, we are interested in the present value of $10,500 received annually for 10 years at a discount rate of 10 percent. By referring to a table of present values, it is found that the present value of $1 received annually for 10 years at a 10-percent discount rate is $6.15. Therefore, $64,500 ($6.15 \times $10,500) is the present value of the total O.S. in our example.

If the present value of O.S. is greater than N.I., then the purchase of the new machine is warranted. By comparing N.I. of $52,500 with the time-adjusted O.S. of $65,500, the conclusion is to make the investment.

In the computation of differential costs, it is necessary to consider depreciation as a tax deductible item. Depreciation of the old machine (before income taxes) is not an incremental cost, because it must be charged off even if the alternative machine is purchased. Depreciation of the new machine (before income taxes) is considered in N.I. as a separate item. In short, depreciation is not considered in computing O.S. before income taxes. In order to acknowledge the tax deduction, the following deduction should be made: O.S. before taxes less increase in allowable deduction for depreciation (the difference between depreciation on old and new machines) $\times$ tax rate $=$ net O.S. after taxes.

Similar to depreciation, the interest paid as a result of the investment will serve as a "tax shield." Therefore, O.S. before taxes must be adjusted in a like manner.

Often when the decision has been made that existing equipment must be replaced or that additional equipment is needed, there is the possibility of renting rather than buying. For example:

Machine A can either be purchased for $10,000 or rented for $1,500 per year for 10 years. Annual operating savings can be computed from the following information:

Annual Costs — Savings	*Rent*	*Buy*	*Differential*
Rentals	1,500	–0–	1,500
Insurance	–0–	100	100*
Maintenance	–0–	200	200*
Depreciation $\times$ tax rate (50%)	–0–	500*	500
Interest paid $\times$ tax rate	–0–	25*	25
Totals	1,500	225*	1,725

(* deduction)

The present value of the cumulative operating savings after taxes at a rate of discount of 15 percent is $8,700. (Rounded to nearest $100). Even though the illustration is over-simplified, it suggests the conclusion that the purchase should not be made. Note that depreciation and interest were again included as a reduction of the investment (after taxes), i.e., an increase in the differential costs.

"Many proposals are so obviously attractive or so obviously unattractive that the decision can be made without any calculations at all. It is important that the unmeasurable factors of investment and rent-or-buy analysis not be neglected."[1] On the other hand, an objective comparison of the consequences of one proposal against another can be most useful in making an unbiased decision.

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[1] *"Management Accounting,"* Robert N. Anthony, Richard D. Irwin, Inc., 1956, p. 411.

Why the Discounted-Cash-Flow Method Is Better and How It Works

by CHARLES W. LENT, JR.

NO PROGRAM of expansion or investment should be considered acceptable unless there is assurance that it will create profits sufficient to provide a fair return on the funds required to carry it through. However, although we all agree on that premise, this is an area which has received altogether too little attention. And there is good reason for this. Even today there are no precise standards as to what the rate of return on funds employed ought to be. Ideas vary, not only between industries but also among companies in the same industry. Furthermore, until quite recently, there has been very little progress in the development of ways to measure return with any degree of preciseness. So long as the results were little more than broad estimates, management has been understandably reluctant to place much reliance on them. On the other hand, even though we have no absolute standards as to what the return ought to be, if we can accurately compare the return on one proposal against the return on another, we will have accomplished something worthwhile.

Generally, there are three steps to take in the process of evaluating a proposed program. The first is to do a fact-finding job. Bring together all available facts, together with reasonable estimates, of sales volumes, selling prices, production costs, operating expenses, inventory, cash and capital requirements, market data, and other business and economic factors pertinent to the program. Second, summarize these facts in such a form that it will enable you to look not only at the facts but also at their relationship to one another. Often it can be done in terms of estimated annual income, before and after taxes, the estimated useful or productive life of the project, and the capital investment or costs required. Third, exercise managerial judgment in asking and answering these questions:

1. Considering the business risks involved, is the estimated return sufficient, especially when compared to the return on funds presently employed?

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2. Is this the right time to make such an investment in the view of developments which may be expected in the near future?
3. Is the opportunity for return large enough to be attractive when considered against all the other available opportunities for investment outside of our business?

Because we are faced with the dilemma of having no absolute guidelines on one hand and the need to make an evaluation and a decision on the other, the least we can do is to make full use of some techniques which, in varying degrees, can help us in evaluating alternate investment opportunities.

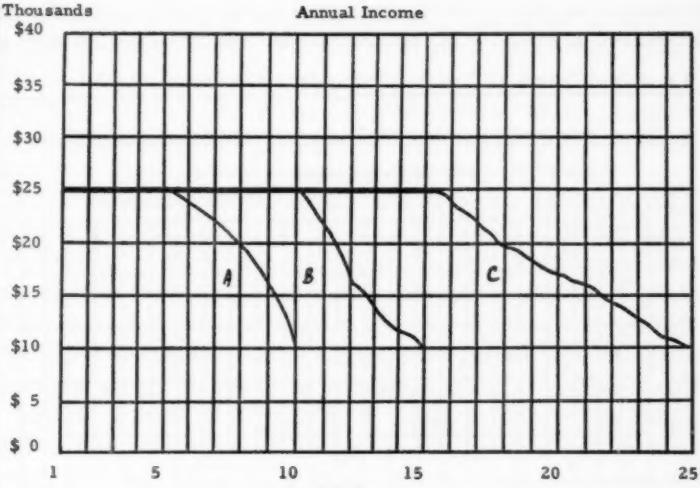
Inadequate Results from Traditional Evaluation Methods

One test that management has frequently and traditionally used is the time period required to pay out the investment. In other words, how soon do we get our money back? Let us review briefly how to make this payout calculation. First, adjust our profit and loss projection to an after-taxes basis. Then add back all noncash costs, such as depreciation on equipment or other amortization charges. Finally, divide the result thus obtained into the gross investment. The answer is the time period required for pay-off.

If we have just a single project, a payout calculation may be of some assistance, especially if the project has a relatively short-term life. If, however, the problem is to determine the relative worth of several programs, extreme caution with this technique should be exercised, because the result may be quite misleading; a return-of-funds calculation simply does not provide an adequate basis for discriminating among alternative investment opportunities, particularly when each of the projects under consideration has an income-producing life of a different period of time. This is because this calculation indicates only how long it will take to recover the original outlay of capital. There is, obviously, little point in making investments which merely return our money, and a payout calculation will not disclose anything regarding the true earning power of an investment. In other words, the real worth of an investment lies in the measure of the income it will produce after the original investment has been returned. And there is no way to determine this from a payout figure.

In order to help us understand this point thoroughly, let us illustrate it with a couple of examples. Exhibit 1 displays a picture of three different projects: *A, B* and *C,* all of which required the same original investment of $125,000. The annual income generated, after taxes and before deducting noncash charges, is $25,000, for a period of five years for *A,* for ten years for *B* and for 15 years in the case of *C,* after which it declines and, finally, disappears.

Differences in Rates of Return When Payout Periods Are Equal



	Project A	Project B	Project C
Original investment	$125,000	$125,000	$125,000
Estimated life of investment	10 years	15 years	25 years
Payout period $\frac{\$125,000}{\$\ 25,000}$	5 years	5 years	5 years
Return on Investment	12%	18%	20%

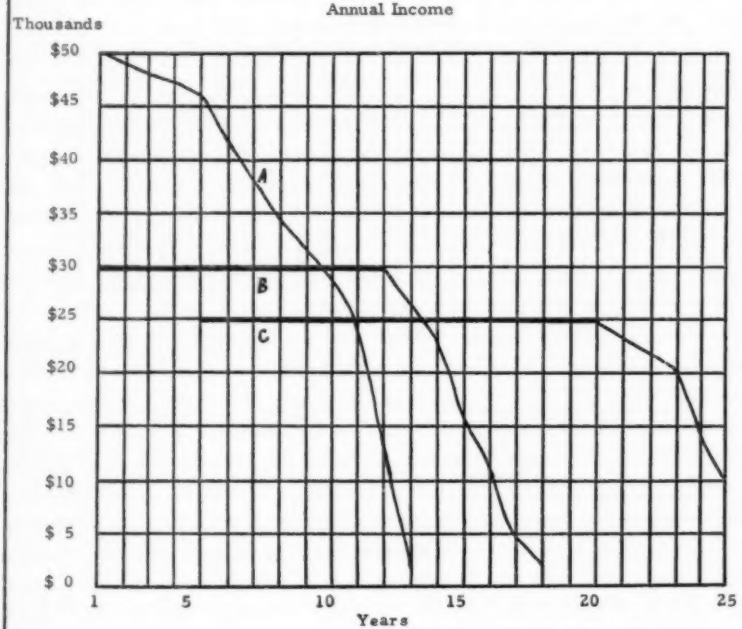
EXHIBIT 1

Since this income figure is equal for all the projects in the early years, all have the same payout period—five years. Thus, if measured only on a return-of-funds basis, all the programs would appear to be equally desirable as investments. Actually, as shown on the bottom line, the return on investment ranges from 12% for *A* with a short life, to 20% for *C* with a much longer life.

On the surface, this all looks pretty simple, and we might be prompted to observe that all we have to do is to look at both the payout period and the total estimated life, in order to reach a logical conclusion. As for the data presented on Exhibit 1, this is true. But it remains true only so long as all the payout periods are equal or, in cases with different payout periods, the total income-producing life of the projects are the same. It is a sad fact,

though, that these conditions do not usually prevail. More often than not, there are differences in both the payout period and the economic life. Under such circumstances it is very difficult to evaluate the relative worth of several projects on the basis of the payout periods alone. For a specific example, let us look at the illustration in Exhibit 2, to see how payout calculations do not serve to

Failure of Payout Payments to Rank Investments in Order of Profitability



	Project A	Project B	Project C
Original investment	$372,000	$267,000	$230,000
Estimated life of investment	13 years	18 years	25 years
Average annual profit after taxes (before depreciation)	$37,200	$26,700	$23,000
Payout based on average income	10 years	10 years	10 years
Payout based on actual income	8 years	8.7 years	11.5 years
Return on investment	5%	8%	8.5%

EXHIBIT 2

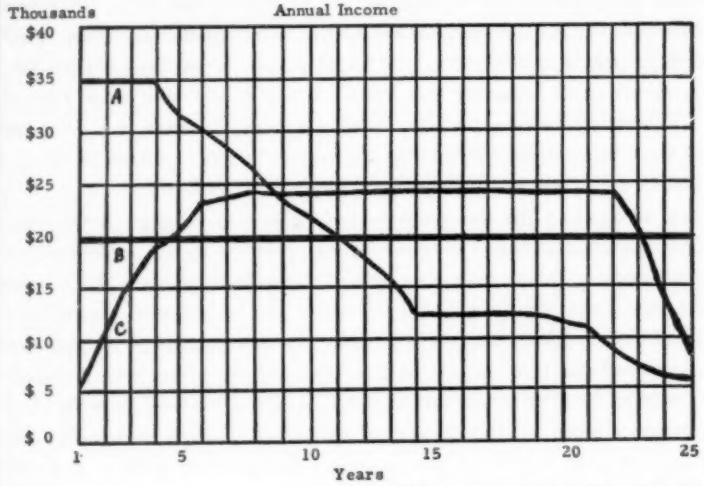
rank investments in order of profitability. In each of the three projects, there is a different amount of original investment and a different estimated economic life. For purposes of this illustration, the average annual profit after taxes, but before depreciation, is calculated to be ten percent of the investment, giving an average payout of ten years. The actual payout varies from 8 years on *A* to 11.5 years on *C*, indicating that Project *A* is most desirable, since it has the shortest investment-return period. Looking further, however, a conventional return-on-investment calculation shows a range of from 5 percent on *A* up to 8.5 percent on *C*, indicating an exact reverse order of profitability.

Thus, recognizing the shortcomings and limitations inherent in the return-of-funds-employed method, we can turn our attention to the return-on-investment technique. There are various general methods of arriving at the return-on-investment answer. Quite different results will be obtained, depending on which of these methods we choose to use. We will discuss the method called the discounted-cash-flow method because, although there has been a considerable coverage of it in accounting literature, it is not too well understood. Its calculation is based on the amount of investment actually outstanding from time to time over the life of the project. The significant point is that funds which are to be received at some date in the future cannot be invested today, they cannot be invested at all until they are received at some future time, and thus they have no earning power until they have been received. For this reason, there is a time-value which must be attached to money. In other words, a dollar available for investment today is much more valuable than a dollar which will become available at some time in the distant future. The discounted-cash-flow technique lets us apply this same approach to the analysis of proposed capital investment projects.

A Comparison and an Application

As pointed out earlier, different methods of applying return on investment produce different results and, to demonstrate the difference, Exhibit 3 compares the results obtained by the three different methods of calculation. The return-on-original-investment calculation indicates a 12-percent return on each project. Likewise, a return-on-average investment shows a 24-percent return in all cases. By these standards, then, there appears to be no difference in the relative merit of the three projects. Actually, however, when we apply the discounted-cash-flow method of computing return, a startling difference appears, in which there is a 24 percent return on Project *A*, 15.5 percent on *B* and only 13 percent on *C*. This variation reflects one important difference among the projects, the

Comparison of Return-on-Investment Calculations



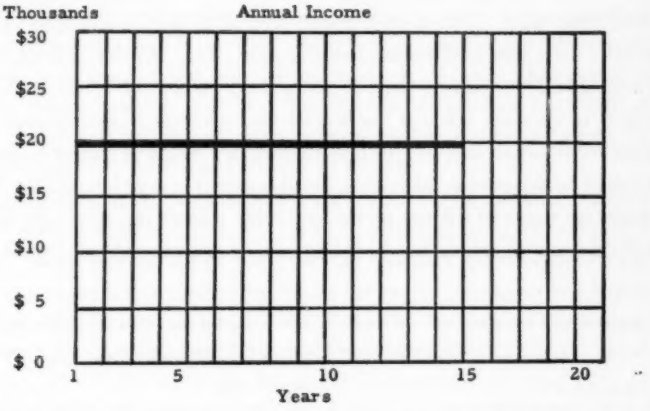
	Project A	Project B	Project C
Original investment	$125,000	$125,000	$125,000
Estimated life of investment	25 years	25 years	25 years
Cum. profit after taxes before depr'n.	$500,000	$500,000	$500,000
Average profit after taxes before depr'n.	$ 20,000	$ 20,000	$ 20,000
Less: Depr'n $\frac{\$125,000}{25 \text{ years}}$ per year	$ 5,000	$ 5,000	$ 5,000
Average profit after taxes after depr'n.	$ 15,000	$ 15,000	$ 15,000
Return on original investment $\frac{\$ 15,000}{\$125,000}$	12%	12%	12%
Return on average investment $\frac{\$ 15,000}{\$ 62,500}$	24%	24%	24%
Return on discounted cash flow method	24%	15.5%	13%

EXHIBIT 3

fact that Project *A* generates a larger share of its total income in the early years of its life. In other words, the investor recovers more of his investment sooner and, therefore, has it available for re-investment. Only the discounted-cash-flow method highlights this very important difference.

The application of the discounted-cash-flow method is illustrated through a simple example shown on Exhibit 4. This example assumes a project which has a uniform annual income. Although the application is less complex than one involving variable income, the principles remain the same, and similar results can be obtained no matter whether the income is level, increasing, declining, or fluctuating over the life of the project. In the example, the estimated

Application of Discounted-Cash-Flow Method in a Situation with Uniform Income



Original investment	$93,500
Estimated life of project	15 years
Average profit after taxes before depr'n	$20,000
Payout period (93,000 ÷ $20,000)	4.68 years
Return on investment	20%

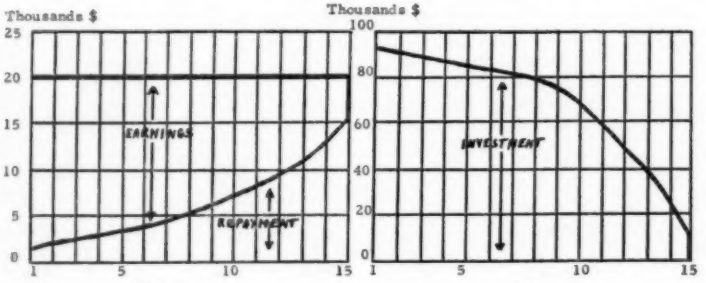
Discount Table

Life of Project	18%	19%	20%	21%	22%
1 year	.847	.840	.833	.826	.820
2 years	1.566	1.547	1.528	1.509	1.492
3 years	2.174	2.140	2.106	2.074	2.042
4 years	2.690	2.639	2.589	2.540	2.494
5 years	3.127	3.058	2.991	2.926	2.864
6 years	3.498	3.410	3.326	3.245	3.167
7 years	3.812	3.706	3.605	3.508	3.416
8 years	4.078	3.954	3.837	3.726	3.619
9 years	4.301	4.163	4.031	3.905	3.786
10 years	4.490	4.339	4.192	4.066	3.923
11 years	4.650	4.487	4.327	4.189	4.035
12 years	4.786	4.611	4.439	4.290	4.127
13 years	4.901	4.715	4.533	4.374	4.203
14 years	4.998	4.802	4.611	4.444	4.265
15 years	5.081	4.876	4.675	4.501	4.315

EXHIBIT 4

profit after taxes, but before depreciation, runs along at $20,000 per year over the fifteen-year life of the project. First, the return of funds is computed in the usual manner by dividing the investment of $93,500 by the average profit after taxes. This gives a payout period of 4.68 years. The next step is to refer to a standard cumulative discount table. At the bottom of Exhibit 4 a section from such a table is reproduced. Since the economic life of the project is 15 years, refer to the line on the table which is designated 15 years. Then move across this line to find the number which is closest to the number obtained in the payout calculation. In this case it is 4.675 as against 4.68. The percentage figure at the top of the applicable column represents the discounted-cash-flow rate of return which, in the case of this example, is 20 percent.

Return Calculated by Discounted-Cash-Flow Method



Year	Annual Income	Repayment of Investment	Available for Earnings	Investment Outstanding	Return on Investment
1	$20,000	$ 1,298	$ 18,702	$ 93,510	20%
2	20,000	1,558	18,442	92,212	20%
3	20,000	1,869	18,131	90,654	20%
4	20,000	2,243	17,757	88,785	20%
5	20,000	2,692	17,308	86,542	20%
6	20,000	3,230	16,770	83,850	20%
7	20,000	3,876	16,124	80,620	20%
8	20,000	4,651	15,349	76,744	20%
9	20,000	5,581	14,419	72,093	20%
10	20,000	6,698	13,302	66,512	20%
11	20,000	8,037	11,963	59,814	20%
12	20,000	9,645	10,355	51,777	20%
13	20,000	11,547	8,426	42,132	20%
14	20,000	13,888	6,112	30,558	20%
15	20,000	16,670	3,330	16,670	20%
	300,000	93,510	206,490	-0-	

EXHIBIT 5

It is apparent that the discounted-cash-flow technique is merely a means of finding the discount rate which, when applied to the anticipated flow of cash income over the life of the project, will make the cash flow equal to the amount of the original capital outlay. In this example, the expected cash income of $20,000 per year over a period of fifteen years, when discounted at 20 percent, is worth exactly as much as the original investment of $93,400. Expressing it still another way, it may be said that the discounted-cash-flow procedure is designed to compute the constant rate of return on the declining balance of the original investment over the economic life of the project.

This is quite clearly demonstrated in Exhibit 5. In the tabulation at the bottom, the cash flow of $20,000 per year for fifteen years is shown in the first column. It is reasonable that some part of this must be set aside to pay back the original investment during the life of the project, as shown in Column 2. The remainder, show in Column 3, reflects the true earnings of the project. The declining balance of the original investment is set up in Column 4, as of the beginning of each year. It can be quickly determined that the ratio of earnings in Column 3 to outstanding investment in Column 4 is 20 percent for each and every year, as indicated in Column 3. The graphs at the top of this exhibit show the division of the annual cash flow between repayment of principal and earnings, on the left, and the declining balance of the investment, on the right side.

It is significant in this particular example that the conventional method of computing return on investment would have given an answer of 15 percent while, if the calculation were based on average investment, the answer would have been 30 percent. Throughout this example, we have assumed a zero salvage value and straight-line depreciation.

Assumptions Can Simplify Applications

In adopting and applying this method in a company, it can be simplified greatly by making assumptions at many points, in order to reduce the complexity of the calculations involved. For the most part, if we do make such assumptions carefully, we shall find that the range of possible error thus introduced is practically negligible, especially when compared with the possibility of the degree of error involved in basic estimates of cash income, costs, investments, and the life of the project. Standard tables of cumulative discounts are available, or we can construct our own. However, the decision to employ the discounted-cash-flow method will, no doubt, be made on one or more of the following considerations:

1. It is the only relatively simple method by which the true rate of return offered by an investment opportunity can be determined.
2. It produces data which are meaningful in relation to those in use throughout the financial world in quoting interest rates on borrowed funds, yields on bonds and for various other purposes. Thus, we can make direct comparisons of the projected returns on investment to the costs of borrowing money. This is not possible with other procedures.
3. It is the only method which makes allowances for the fact that investments may generate income at different times in their lives. In this way, it helps discriminate between projects which may have increasing, declining, level, or fluctuating incomes.

In closing, it may be said that, when and if properly applied, the calculation of return of and on funds employed is of tremendous value in arriving at management decisions and, also, that among the various approaches which are available, the advantages of the use of the discounted-cash-flow technique are obvious.

Determining Rate of Return on Projects by Discounted-Cash-Flow Technique

by ROBERT J. DONACHIE

CAPITAL INVESTMENT for business profits is the very foundation of the free enterprise system. In today's dynamic economic environment, with steady increases in technology, the accompanying risk of obsolescence and continually tightening competition, the need to invest wisely is more intense than at any time in history. This is partly because a growing business climate, while conducive to new capital investment, frequently places severe limitations on the funds available for such expenditures. Management must, therefore, weigh each anticipated expenditure carefully to make sure that available funds are used to best advantage. Furthermore, it is equally important that funds available not be allowed to remain idle if the enterprise is to continue to grow and prosper.

Capital or money, to be effective, must be employed. Since the investment of money involves risk, the question to be answered is—How should available funds be employed to obtain maximum advantage for the business enterprise with minimum risk? This paper will describe some of the measures, tools or devices available to assist management in making this decision.

Reasons for Capital Investment

In general, capital investments fall into two categories: some become necessary because of replacement of equipment, elimination of hazards, or equipment breakdown, etc., the others are made specifically to increase profits. We are not concerned here with those which are regarded as necessary for the reasons given, since these investments generally must be made even if they do not produce any measurable increase in profit. It is, rather, capital expenditures that are made to increase profits which are the subject of our concern. Management, in deciding upon such ventures, must consider the sources of increased profit and the ultimate risk involved.

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Increased profits in general are the result of either savings or increased sales. Therefore, the evaluation of new capital expenditures involves three basic steps:

1. Estimation of economic factors which will contribute to profit, i.e., amount of sales increase, potential savings, etc.
2. Summary of economic data in convenient form for appraisal of the proposed venture. This involves establishing yardsticks or uniform criteria for evaluating one project versus another.
3. Exercise of managerial judgment to determine:
   a. Whether the anticipated return is large enough to warrant the risk involved.
   b. Whether the investment opportunity is attractive as compared with alternative ways of investing.
   c. Whether the timing is right relative to anticipated developments in the future.

Step No. 2 is our chief concern. We shall consider the establishment of the yardsticks for measurement of capital investment and why such yardsticks are necessary.

Methods for Calculating Return on Investment

Profit measurement is the primary motivation for analyzing the potential return on a capital investment. Since the generation of profit is contingent upon many and diverse factors, a method must be developed which adequately measures these factors in their proper perspective for a particular project. Capital expenditures, unlike everyday expenditures for supplies, repairs, etc. have a significant and long-term effect on company profits. It therefore behooves management to weigh each project carefully.

In the search for more reliable and accurate methods for evaluating capital investments, many techniques of determining return on investment have been evolved, with varying degrees of accuracy and reliability. To date, one of the most satisfactory methods in use is known as the discounted-cash-flow technique. To illustrate its advantages, we shall first briefly consider some of the other methods in use and their shortcomings as compared with the discounted-cash-flow method.

Pay-back method. This is less a way of determining return on investment than return of it. Under this method the prime consideration is the number of years required to return the cash to the till. For example, if an investment of $20,000 provided annual depreciation of $4,000 and after taxes earnings of

$6,000 or a total of $10,000 annually, then the pay-back period would be calculated as follows: $20,000 ÷ $10,000 = 2 years. This method does not recognize that earnings will continue over the life of the project, which may be many years. Furthermore, management is not interested in investing funds merely to be repaid. It should be noted, however, that pay-back is a good guide for evaluating how long the risk element of an investment will be a consideration.

Original-investment method. This is a method by which the average annual earnings over the life of the investment are compared with the amount of the original investment. This method does not recognize that the investment gradually decreases while earnings may vary significantly from year to year. For example, the results obtained under this method for an original investment of $20,000 to earn $6,000 annually would be expressed as $6,000 ÷ $20,000, or 30 percent.

Average-investment method. By this method annual earnings are compared with the average investment to arrive at a rate of return. However, as a guide, it still has the same shortcomings as the original-investment method. For example, for an investment of $20,000 to earn $6,000 annually, the calculated rate of return would be: earnings $6,000 ÷ average investment $10,000, or a return of 60 percent. The assumption, of course, is that the average investment outstanding over the life of a project is ½ the original investment.

Discounted-cash-flow method. Rather than to affix a precise technical definition to the discounted-cash-flow technique, let us consider it as a concept or philosophy of investment which acknowledges that a dollar invested today will be paid off in tomorrow's dollars and that the investment required today to earn one dollar in the future is substantially less than one dollar, depending upon the length of time of the investment and the interest rate earned. For example, to have one dollar available one year from today would only require the investment of $.9433 at 6 percent. ($.9433 x 1.06 = $1.00). From this we can see that, if the amount of the investment is known and the return of cash by year can be predicted, the effective rate of return is the percent or factor which, when applied to future dollars, will recoup all of the present investment over the entire life of the project. To raise this illustration to thousands of dollars by moving the decimal point and then to use it in the reverse direction, if we had invested $9,433 in a new plant and the projected cash flow for the first year were $10,000, our return on investment would be 6 percent. This is the same as saying that $10,000 received one year from today is sufficient to pay off an investment of $9,433 made at the present time. As contrasted with the other methods described, the discounted-cash-flow method offers the following advantages:

1. Recognizes that a sum of money to be received at some future time is worth less than the same sum available today and translates a future sum into its equivalent present value.
2. Bases the calculation of the rate of return on the investment actually outstanding from time to time over the life of the project and fully considers the cost of a project and the earnings expected from it over its entire life.
3. Places a time value on money by recognizing that funds to be received at some future date cannot be profitably invested until that time.

Illustration of Discounted-Cash-Flow Computation

To illustrate the application of the discounted-cash-flow technique, a few examples have been developed to show return on investment calculated by the discounted-cash-flow technique in comparison with return calculated by other methods in frequent use. Each of the following situations relates to an investment of $240,000 with a 20-year life, depreciated at 12,000 annually, i.e., on a straight-line basis with total earnings of $480,000 over the project's life. However, the timing of these earnings differs with each case, as noted in the headings of Exhibit 1. Aside from pay-back—not really a return-on-investment computation—the computed rates of return are the same for each project, except for the rates computed on a discounted-cash-flow basis. The total earnings and depreciation over the entire life of the project are the same from any viewpoint. The only difference is one of timing or the rate at which the investment is returned. The discounted-cash-flow method recognizes desirability of investing in projects with an accelerated return and, as such, gives weight to the decrease in the amount of investment outstanding as a result of the accelerated return of funds.

Comparison Table of Return on Investment
Investment $240,000 Life 20 years

Method	A/Earn. $24000/yr. uniformly over 20 yrs. -Depr. $12000 annually	B/Earn. $60000/yr. 5 yrs. $ 12000/yr. 15 yrs. - Depr. $12000 annually	C/Earn. $12000/yr. 5 yrs. -$28000/yr. 15 yrs. - Depr. $12000 annually
Payback	6.6 yrs.	3.3 yrs.	8.0 yrs.
Rate of Return on Investment:			
1. Discounted cash flow	14.2%	23.8%	12.1%
2. Original investment	10.0%	10.0%	10.0%
3. Average investment	20.0%	20.0%	20.0%

EXHIBIT 1

COMPUTATION OF RETURN ON INVESTMENT
DISCOUNTED CASH FLOW METHOD

INVESTMENT: $240,000 LIFE: 20 YEARS

		SITUATION A						SITUATION B						SITUATION C					
				DISCOUNTED					DISCOUNTED						DISCOUNTED				
YEAR	DEPRE-CIATION	AFTER TAX EARNINGS	CASH FLOW	RATE 12% FACTOR		RATE 15% FACTOR		EARNINGS	CASH FLOW	RATE 24% FACTOR		RATE 21% FACTOR		EARNINGS	CASH FLOW	RATE 15% FACTOR		RATE 12% FACTOR	
1	$ 12,000	$ 24,000	$ 36,000	.942	$ 33,912	.929	$ 33,444	$ 60,000	$ 72,000	.889	$ 64,008	.902	$ 64,494	$ 12,000	$ 24,000	.929	$ 22,296	.942	$ 22,608
2	12,000	24,000	36,000	.836	30,096	.799	28,764	60,000	72,000	.699	50,328	.731	52,632	12,000	24,000	.799	19,176	.836	20,064
3	12,000	24,000	36,000	.741	26,676	.688	24,768	60,000	72,000	.550	39,600	.593	42,696	12,000	24,000	.688	16,512	.741	17,784
4	12,000	24,000	36,000	.657	23,652	.592	21,312	60,000	72,000	.433	31,176	.480	34,560	12,000	24,000	.592	14,208	.657	15,768
5	12,000	24,000	36,000	.583	20,988	.510	18,360	60,000	72,000	.340	24,480	.389	28,008	12,000	24,000	.510	12,240	.583	13,992
6	12,000	24,000	36,000	.517	18,612	.439	15,804	12,000	24,000	.268	6,432	.316	7,584	28,000	40,000	.439	17,560	.517	20,680
7	12,000	24,000	36,000	.459	16,524	.378	13,608	12,000	24,000	.211	5,064	.256	6,144	28,000	40,000	.378	15,120	.459	18,360
8	12,000	24,000	36,000	.407	14,652	.325	11,700	12,000	24,000	.166	3,984	.207	4,968	28,000	40,000	.325	13,000	.407	16,280
9	12,000	24,000	36,000	.361	12,996	.280	10,080	12,000	24,000	.130	3,120	.168	4,032	28,000	40,000	.280	11,200	.361	14,440
10	12,000	24,000	36,000	.320	11,520	.241	8,676	12,000	24,000	.103	2,472	.136	3,264	28,000	40,000	.241	9,640	.320	12,800
11	12,000	24,000	36,000	.284	10,234	.207	7,452	12,000	24,000	.081	1,944	.111	2,664	28,000	40,000	.207	8,280	.284	11,360
12	12,000	24,000	36,000	.252	9,072	.178	6,408	12,000	24,000	.063	1,512	.090	2,160	28,000	40,000	.178	7,120	.252	10,080
13	12,000	24,000	36,000	.223	8,028	.154	5,544	12,000	24,000	.050	1,200	.073	1,752	28,000	40,000	.154	6,160	.223	8,920
14	12,000	24,000	36,000	.198	7,128	.132	4,752	12,000	24,000	.039	936	.059	1,416	28,000	40,000	.132	5,280	.198	7,920
15	12,000	24,000	36,000	.176	6,336	.114	4,104	12,000	24,000	.031	744	.048	1,152	28,000	40,000	.114	4,560	.176	7,040
16	12,000	24,000	36,000	.156	5,616	.098	3,528	12,000	24,000	.024	576	.039	936	28,000	40,000	.098	3,920	.156	6,240
17	12,000	24,000	36,000	.138	4,968	.084	3,024	12,000	24,000	.019	456	.031	744	28,000	40,000	.084	3,360	.138	5,520
18	12,000	24,000	36,000	.123	4,428	.072	2,592	12,000	24,000	.015	360	.025	600	28,000	40,000	.072	2,880	.123	4,920
19	12,000	24,000	36,000	.109	3,924	.062	2,232	12,000	24,000	.012	288	.021	504	28,000	40,000	.062	2,480	.109	4,360
20	12,000	24,000	36,000	.096	3,456	.054	1,944	12,000	24,000	.009	216	.017	408	28,000	40,000	.054	2,160	.096	3,840
TOTALS	$240,000	$480,000	$720,000		$272,808		$228,096	$480,000	$720,000		$238,896		$260,718	$480,000	$720,000		$197,152		$242,976

NOTE: CASH FLOW IS EQUAL TO THE SUM OF ANNUAL DEPRECIATION PLUS ANNUAL EARNINGS

TO DETERMINE THE DISCOUNT FACTOR, REFER TO THE PRESENT WORTH TABLE

EXHIBIT 2

On an original investment basis, the computation in each of the three cases plainly is that $480,000 was returned in 20 years on an investment of $240,000. This is $24,000 per annum or 10%. On an average investment—half-way between $48,000 at the start and zero at the end,—$480,000 was returned in 20 years on $120,000. The same $24,000 is 20% per annum. However, income is to be realized on a different time schedule in each situation, and this the discounted-cash-flow method of evaluation recognizes.

Exhibit 2 illustrates the calculation of the return on investment using the discounted-cash-flow method for the three economic situations described previously. To assist in understanding it, the mechanics of the calculations are given below:

1. *Cash flow.* The amount shown under this column heading is the sum of annual depreciation plus annual earnings for each year of the project life. For example, in Situation A the cash flow for each year is the same, $12,000 depreciation plus $24,000 earnings or a total of $36,000 annually.

2. *Discounted cash flow.* From Exhibit 3, the table of present worth, a factor or in this case a series of factors is determined which, when applied consistently to the cash flow by year over the life of the project, results in an amount equal to the original investment. This series of factors, of course, represents the present worth of $1 invested at some determinable interest rate and received at some future date. This calculation will not always be exact, as is illustrated by Situation A in Exhibit 2. Using the discount factors for 12-percent return results in an accumulated cash flow of $272,-908, which is more than the total investment. By the same token, the discount factors for a 15-percent return result in less than the amount required. Therefore, we must interpolate, as described in more detail later, to determine the exact percentage of return.

3. *Determining the discount factor.* The determination of the discount factor is largely a matter of trial and error. However, this is usually not difficult. Simply scanning the overall cash flow by year will usually provide an indication of the factors which, when applied, will produce an amount equivalent to the original investment. For example, in Situation A, the discount factors selected first were for a return of 12 percent. Therefore, the factors used as obtained from Exhibit 3 were .942 for the first year, .836 for the second year, etc. Application of these factors over the 20-year period resulted in an amount larger than the investment, which indicates that we discounted too heavily. Therefore, we try discounting with a lesser factor.

Present Worth Tables

Modified to Center Discounting in Each Year

Present Worth of 1.00 if the yield or discount rate is:

YEAR	3%	6%	9%	12%	15%	18%	21%	24%	27%	30%	40%	50%	60%	YEAR
1	.985	.971	.956	.942	.929	.915	.902	.889	.876	.864	.824	.787	.752	1
2	.956	.914	.874	.836	.799	.764	.731	.699	.669	.640	.553	.477	.413	2
3	.928	.861	.799	.741	.688	.639	.593	.550	.511	.474	.370	.290	.227	3
4	.900	.811	.730	.657	.592	.533	.480	.433	.390	.351	.248	.176	.124	4
5	.874	.764	.667	.583	.510	.446	.389	.340	.298	.260	.166	.107	.068	5
6	.848	.719	.610	.517	.439	.372	.316	.268	.227	.193	.112	.065	.037	6
7	.823	.677	.557	.459	.378	.311	.256	.211	.173	.143	.075	.039	.021	7
8	.799	.638	.509	.407	.325	.260	.207	.166	.132	.106	.050	.024	.011	8
9	.775	.601	.466	.361	.280	.217	.168	.130	.101	.078	.034	.014	.006	9
10	.752	.566	.425	.320	.241	.181	.136	.103	.077	.058	.023	.009	.003	10
11	.730	.533	.389	.284	.207	.151	.111	.081	.059	.043	.015	.005	.002	11
12	.708	.502	.355	.252	.178	.126	.090	.063	.045	.032	.010	.003	.001	12
13	.687	.472	.325	.223	.154	.106	.073	.050	.034	.024	.007	.002	.001	13
14	.667	.445	.297	.198	.132	.088	.059	.039	.026	.018	.005	.001	---	14
15	.647	.419	.271	.176	.114	.074	.048	.031	.020	.013	.003	.001	---	15
16	.628	.395	.248	.156	.098	.061	.039	.024	.015	.010	.002	---	---	16
17	.610	.372	.227	.138	.084	.051	.031	.019	.012	.007	.001	---	---	17
18	.592	.350	.207	.123	.072	.043	.025	.015	.009	.005	.001	---	---	18
19	.574	.330	.189	.109	.062	.036	.021	.012	.007	.004	.001	---	---	19
20	.557	.310	.173	.096	.054	.030	.017	.009	.005	.003	---	---	---	20
30	.413	.170	.070	.029	.012	.005	.002	.001	---	---	---	---	---	30
40	.306	.093	.029	.009	.003	.001	---	---	---	---	---	---	---	40
50	.226	.051	.012	.003	.001	---	---	---	---	---	---	---	---	50

EXHIBIT 3

4. *Interpolating.* In Situation A, since the 12-percent discount rate produces a result of $272,908 and the 15-percent discount rate results in $228,096 over the life of the project, the actual rate of return to produce the present worth of $240,000, our original investment, must be somewhere in between these two rates. To find the exact rate we:
   a. Subtract the smaller number from the larger number:
      $272,908 — 228,096 = $44,812.
   b. Subtract the original investment from the larger number:
      $272,908 — 240,000 = $32,908.
   c. Divide the difference obtained in Step a. by the difference obtained in Step b. to obtain a percentage of difference:
      $\frac{\$32,908}{\$44,812} = 73.4\%$.
   d. Multiply the percentage of difference obtained in Step c. by the difference in the investment rate:
      $3\% \times 73.4\% = 2.2\%$.
   e. Add the answer from Step d. to the lowest investment rate:
      $12\% + 2.2\% = 14.2\%$ — effective rate of return.

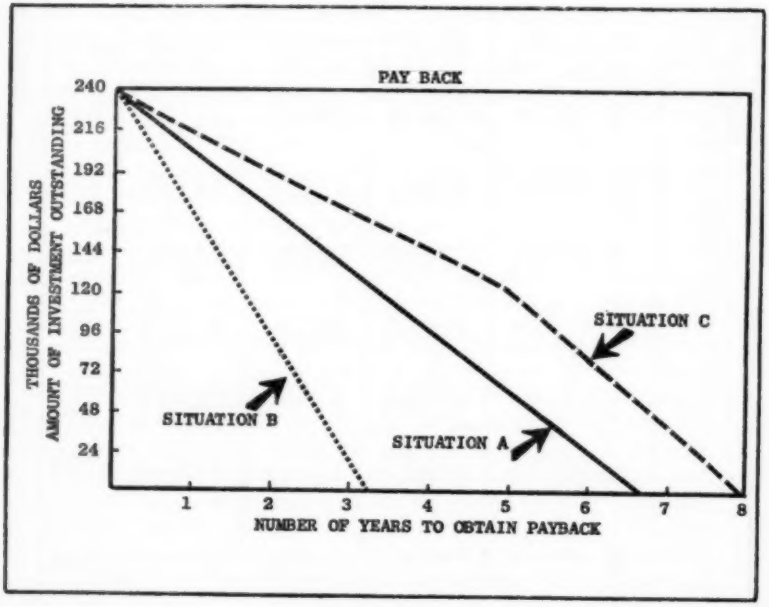

EXHIBIT 4

To assist in understanding the results of the computations shown in Exhibit 2, charts have been prepared to graphically present cash flow on the pay-back period as well as return on investment.

The chart shown as Exhibit 4 indicates the rate of decline in the amount of investment outstanding as a function of cash flow for each of the three economic situations previously discussed.

The rate of cash flow over the entire life of the project is graphically indicated by Exhibit 5. Note that, with the acceleration of cash flow, the ultimate return on investment increases.

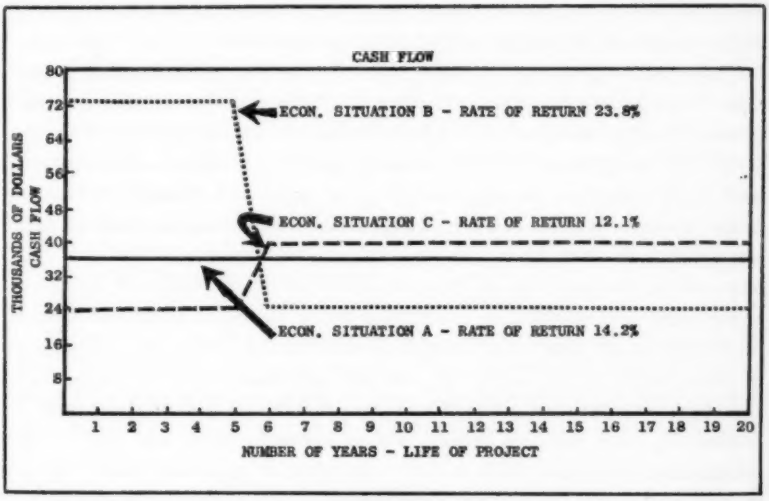
CASH FLOW
THOUSANDS OF DOLLARS CASH FLOW
80
72
64
56
48
40
32
24
16
8
ECON. SITUATION B - RATE OF RETURN 23.8%
ECON. SITUATION C - RATE OF RETURN 12.1%
ECON. SITUATION A - RATE OF RETURN 14.2%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
NUMBER OF YEARS - LIFE OF PROJECT

EXHIBIT 5

Reliable Tool for General Use

From the description of the discounted-cash-flow technique just given, with an analysis of the results produced, it can be seen that this approach to evaluating capital expenditures offers management a reliable tool for discriminating between alternative proposals. The basic data required is the same as required for any other formula for determining return on investment. Potential earnings after taxes and annual depreciation must be determined. Having developed this data, all that remains is the application of arithmetical calculations previously described. The fact that the earnings may vary from year to year or that annual depreciation may vary because of accelerated methods employed to gain tax advantages, in no way inhibits the use or vitiates the results of the discounted-cash-flow formula.

Using Payout Calculations for Equipment Replacement

by RICHARD C. GRANT

THE TREMENDOUS industrial expansion, technological advancement, and complexity of business in recent years has compelled many companies, both large and small, to expand their plant and equipment, develop new products and revise production methods. The volume and frequency of expenditures for capital equipment has compelled the accountant to develop new tools and devices for control and justification. One of these devices is to use a means of reducing business decisions to mathematical presentations.

These are not generally applicable when the decision relates to plant expansion. Usual reasons for plant expansion are (1) to install more equipment for production of present products, (2) to develop new or related products or (3) to go into undeveloped markets with new products. Decisions on matters of such significance to a company can rarely be reduced to formulas. There are many economic analyses and accounting studies which must be made to assist management in reaching conclusions justifying an expansion. The final decision will be one primarily of judgment and experience. There are exceptions to this view. For example, an oil company should be able to reduce the decision of whether to add new stations largely to mathematical computation. Operators of chain stores, motels, hotels, etc., can also use mathematical analysis in making expansion decisions. However, a manufacturer of cotton goods who is considering entry into the related field of synthetic fibers will find no one combination of figures which will take the place of experience and judgment in making such a decision because the move involves so many imponderables.

The problem of replacement of equipment is an entirely different matter. This presents an engineering problem, and most engineering problems are subject to some type of finite measurement. Let us consider, however, two types of replacement and see if this is true of both. The first of these is the replacement of equipment which is worn out or inoperative because of physical reasons. Very little choice exists here and, again, it would seem that mathematical computation has little to offer. If a power plant goes out of service because of a worn out boiler, the first consideration will be to get it back in service. A choice may be made between overhauling the boiler or replacing it, but timing will be

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a more important consideration than cost. If time is not a consideration, the advantages of overhaul versus replacement can be reduced to arithmetic and probably should be. It is suggested, however, that the main objective is getting service resumed and too much time should not be spent in controversial analysis.

It is in the area of replacement of equipment because it has outlived its economic life that the application of mathematical computation comes into its own, for equipment has outlived its economic life or becomes obsolete only when there is new equipment which will do the job better, meaning cheaper. It then becomes necessary to know how much cheaper and whether the resulting savings will justify the expenditure for new equipment. A mathematical analysis which has proven to be very satisfactory in helping our management make sound decisions is a four-page Cost and Savings Report. If a request is made for the replacement of equipment, an analysis is made comparing the advantages of the new equipment over the old. This analysis cites cost savings and economic analyses estimating increased profit. There are four basic steps in the preparation of this report:

1. Determine the cash requirement.
2. Determine increased annual operating profit and annual cash return.
3. Calculate cash return period.
4. Determine initial non-recurring expense and obsolescence charges.

The remainder of this article explains in detail the four basic steps. To help understand the basic theme, an example of a completed report for the replacement of a lathe with one which operates 100 percent faster is shown part by part as illustration. The first of the four pages shows the results, as follows for the example used:

COST AND SAVINGS REPORT (Page 1 of 4)

Proposal:

Replace present lathe with lathe which will operate 100% faster.

Summary:

Estimated cash return period	3.9 Yrs.
Estimated increase in annual operating profit (before taxes)	$960.00
Initial non-recurring expense and obsolescence charge (before taxes)	$490.00

Discussion:

Present lathe is operated approximately six hours per day, 1,260 hours per year. Proposed new lathe can do same work in 660 hours per year, a saving of 600 hours.

The new lathe will also do better precision work with resulting reduction in losses.

———— Division Controller

The Determination of Cash Requirements

The figures required for the above summarization are developed on the succeeding pages of the report. Cash requirements are fundamental and are the concern of the second page. The first item is the cost of the new equipment or facility itself, including installation. To this is added non-recurring expense such as relocation of present equipment and removal of obsolete equipment. The sum of these two figures is the amount to be authorized if the project is to be undertaken. Our practice is to add engineering expense at this point. Engineering is a continuing expense and is not separately authorized for each project. It is, therefore, not a cash outlay but is a part of the total cost and may be assigned an amount, although this is not done in the example. The total cost of all expenditures is reduced by the taxes on income that are saved by the deductible expenditures, the taxes on income saved by the write-off of obsolete equipment, and sale or scrap value of the obsolete facilities. (The detail of this computation is made on the final page of the report). The Page 2 results for the example, as outlined above, are shown as in the statement blow:

COST AND SAVINGS REPORT (Page 2 of 4)

	Detail		
1. *Cash Requirements*			
a. Gross Capital Expenditure (Itemize)			
15" Lathe	$2,700.00		
Installation	100.00		
Total		$2,800.00	
b. Non-Recurring Expense Other Than Engineering Expense (Itemize)			
Removal of old lathe	$15.00		
Repair flooring under lathe	75.00		
Total		$ 90.00	
c. Total Amount to Be Authorized (a+b)		$2,890.00	
d. Engineering Expense		None	
e. Gross Cash Requirements (c+d)			$2,890.00
f. Less: Cash Return on Misc. Expense & Obsolescence Charge (From Page 4, Item d)		350.00	
g. Net Cash Requirements (e—f)			$2,540.00

Increased Annual Operating Profit and Annual Cash Return

We now move to a determination of the increased annual operating profit and annual cash return. This computation is made on Page 3 of the report. The gross savings are determined by a comparison of the cost of present and

proposed methods, usually comparing the units of output. The following are some of the elements of cost that may be affected to achieve a savings:

Hourly labor	Packaging expense
Salaried personnel	Freight and drayage
Employee benefits	Fixed expense
Utilities	Material costs
Maintenance expense	Administrative costs

In the example we are using, the new piece of equipment operates 100 percent faster than the replaced equipment. The savings are in direct labor and employee benefits. The recurring expense to be included here consists of new items caused by the new capital investment. For example, the addition of new equipment will usually increase annual maintenance, property taxes, insurance and depreciation. In the sample Page 3 below, it will be noted that the figure of $960 increase in profit is one of the three figures carried up to Page 1, though the analysis below carries on to after-tax profit and annual cash return:

COST AND SAVINGS REPORT (Page 3 of 4)

2. *Increased Annual Operating Profit & Annual Cash Return*

a. Gross Saving (Itemize)		
Direct labor—600 hours $1.75	$1,050.00	
Fringes—20%	210.00	
Total		$1,260.00
b. Less: Recurring Expense (Itemize)		
Property taxes	$ 44.00	
Insurance	20.00	
Depreciation	236.00	
Total		$300.00
c. Increased Profit Before Income Tax (a—b)		$960.00
d. Less Income Tax (56%)		$538.00
e. Increased Profit After Income Tax (c—d)		$422.00
f. Add: Depreciation Charged		$236.00
g. Total Annual Cash Return (e + f)		$658.00

Tie-in with Summary

The fourth and final page of the Cost and Savings Report contains two items and provides the support for the remaining two figures on the summary sheet represented by Page 1. To begin with, the net cash requirement figure of $2,540 developed on Page 2 of the report is divided by the annual cash return developed on Page 3 to arrive at the cash return period, which turns out to be

3.9 years. Items a to c on Page 4 work out—through consideration of expenses to be occasioned by the replacement, scrap on the old equipment, and obsolescence incurred—the amount of $490 which is carried to Page 1. Item d. details the amount of cash return which was deducted from gross cash requirements to arrive at net cash requirement on Page 2 of the report. Page 4 follows:

COST AND SAVINGS REPORT (Page 4 of 4)

3. *Cash Return Paid (1 + 2)*	2,540 ÷ 658		= 3.9 yrs.
4. *Initial Non-Recurring Expense & Obsolescence Charge*			
a. Non-Recurring Expense (Itemize)			
Removal of old lathe		$15.00	
Repair flooring under lathe		75.00	
Total			$90.00
b. Obsolescence Charge			
Net Book Value of Facilities (Itemize)			
Original cost of obsolete lathe		$1,500.00	
Accrued depreciation		900.00	
Total		$600.00	
Less: Sale or Scrap value		200.00	
Net Obsolescence Charge			$400.00
c. Total Initial Non-Recurring Expense & Obsolescence Charge (a + b)			$490.00
d. Cash Return From Initial Non-Recurring Expense & Obsolescence Charge			
Reduction in taxes from initial expense (56%)		$ 50.00	
Sale or scrap value of obsolete facilities		200.00	
Reduction in taxes from writeoff of obsolete facilities (25%)		100.00	
Total Cash Return			$350.00

Workable Procedure

To some this may seem like an unduly complex procedure. To others, it may seem like an unduly complex instruction for a relatively simple procedure. However, the procedure is being used by a substantial number of engineers, many without accounting training, and no insolvable problems have cropped up. The method compels management to think in terms of profit and it also compels the accountant to carry out regular programs of performance review to confirm that proposed savings are actually achieved. The knowledge that this is done puts a positive responsibility for profit on the individual proposing new capital expenditures.

The Judgment Factor in Capital Planning

by RICHARD P. CONNELLY

OUR COMPANY started in business 81 years ago as a small shop for the production of bicycles. Today it is classed as a metal fabricator with annual sales of about $280,000,000 and 15,000 employees located in 13 plants, together with numerous sales offices. With the acquisition of many plants during and after World War II and a great increase in the number of products, the company decentralized along product lines. Each product division has a manager who is held responsible for profit. He is responsible for all phases of his operation, including sales, manufacturing, engineering, accounting, and personnel. Some product managers are responsible for more than one plant; some are responsible for just part of a plant; but in all instances each is fully responsible for the profit of his product.

We are continually searching for better ways to evaluate expenditure requests and to control expenditures, themselves. Many procedures have been adopted and frequently revised to solve the basic problems of:

1. How much money should the corporation spend?
2. How should the agreed total be distributed?
3. How should the unit total be spent?

Constant Inflow of Ideas and Proposals

In our company there are many sources of ideas for new equipment; some of them are:

1. Employee suggestions plan—the company pays $5 to $1,000 for acceptable ideas.
2. Machinery and equipment salesmen.
3. Employee visits to equipment shows—each visit must result in a report on two machines which will reduce cost or improve quality, with rough cost of investment and an analysis of return we could expect.
4. Employee visits to plants of other companies, usually as a result of a lead on an interesting equipment application.

RICHARD P. CONNELLY, Milwaukee Chapter, 1957, is a Management Specialist in the Management Controls and Operations Analysis Department of the A. O. Smith Corporation, Milwaukee, Wisc. Mr. Connelly is a graduate of Xavier University, Cincinnati, Ohio.

5. Manufacturing panel—the two division engineers plus staff engigineers meet monthly for interchange of ideas. They also visit the company's plants.
6. Plant engineer's replacement analysis. Utilizing our tabulating equipment, we furnish a monthly report which shows the material and labor spent for repairs on each machine in our shop. These monthly figures are also accumulated by month, showing what each machine has cost for repairs for one year-to-date. Repairs to each piece of equipment are coded, so that we know what caused the need for repair. The categories are normal wear, defective parts, design weakness, operational carelessness, or error in adjustment. Parts affected or type of repair is also shown in the following categories: general overhaul, clutch, brake, motor, electrical controls, mechanical, hydraulic or lubrication. This record points out what equipment should be examined by the line people and helps to make a decision whether the equipment should be rebuilt or replaced.
7. Profit improvement committees. Each division has a committee of six salaried employees. Each month the most effective committee of six, with their wives, is given $250 for an evening on the company. A three-time winner in a twelve-month period receives a company-paid three-day vacation trip to a resort of their choice.

Proposal Evaluation and Capital Planning

The chief process engineer and the cost reduction engineer are a team of two to review, classify and evaluate all proposals for new equipment. Each capital proposal which passes their scrutiny is recorded on a Capital Project Request Control Card (Exhibit 1) in duplicate.

Under our present plan, capital expenditure requests are classified into five categories:

1. NR projects—Normal replacements.
2. NP projects—New products.
3. X projects—Expansion of plant capacity.
4. CR projects—Cost reduction.
5. PLI projects—Plant improvement.

A key feature of our plan is that capital planning within a division will begin at least one year prior to the fiscal year in which the expenditure will be made. To accomplish this, a system is established in each division by which periodic reviews are made of capital expenditures which might be required or desirable in the succeeding fiscal year.

DIVISION REQUESTING

PRIORITY NUMBER

PROJECT NUMBER

CAPITAL PROJECT REQUEST CONTROL CARD

D-2103 Rev. 2 Fin.-FA

Project Description:

Project Classification:

- ☐ Normal Replacement
- ☐ Model Change
- ☐ Plant Improvement
- ☐ Expansion
- ☐ Cost Reduction
- ☐ New Products
- ☐ Milwaukee Modernization Program

Funds Required

	Capital 19___-19___	Expense 19___-19___
Division Request		
/Capital Review		
/Capital Budget		
Project Amount		
(Over)/Under Budget		

EXPENDITURE SCHEDULE (000 Omitted)

19___-19___					19___-19___				
1ST QTR	2ND QTR	3RD QTR	4TH QTR	TOTAL	1ST QTR	2ND QTR	3RD QTR	4TH QTR	TOTAL

Useful life of asset: _____ Years Estimated rate of return: (Added net income ÷ Added investment) _____ %

Effect on manufacturing costs: _____

Effect on capacity: _____

Effect on selling price: _____

Will sales volume be increased? _____

Description of necessity or desirability: _____

IN THE EVENT THAT ECONOMIC EVENTS DICTATE REDUCTIONS TO THE CAPITAL PROGRAM STATE ALTERNATIVE ON REVERSE SIDE

Decision of Capital Review Committee: _____

Capital Budget Decision: _____

EXHIBIT 1 (Face)

Routing: Project Request			Approp. No.		Approp. No.		Approp. No.		Approp. No.		Approp. No.		Approp. No.	
MCOA - Date Received			Date Forwarded	Date Returned	Date Forwarded	Date Returned	Date Forwarded	Date Returned	Date Forwarded	Date Returned	Date Forwarded	Date Returned	Date Forwarded	Date Returned
	Date Forwarded	Date Returned												
Tax Department														
Vice President of Mfg.														
Vice President of Engr.														
Final Approval														
Date Approved														

	Approp. No.		Approp. No.		Approp. No.		Approp. No.		Approp. No.		Approp. No.		Approp. No.	
	Date Forwarded	Date Returned	Date Forwarded	Date Returned	Date Forwarded	Date Returned	Date Forwarded	Date Returned	Date Forwarded	Date Returned	Date Forwarded	Date Returned	Date Forwarded	Date Returned
Tax Department														
Vice President of Mfg.														
Vice President of Engr.														
Final Approval														
Date Approved														

EXHIBIT 1 (Back)

The division completes its proposed capital budget for the succeeding fiscal year in the first part of the third fiscal quarter. Priority numbers are assigned to each project. The highest priority number is assigned to proposals which the division believes will yield the greatest advantage or highest return on investment. This annual evaluation is performed in January by a divisional equipment review board composed of division manager, plant engineer, shop superintendent, and the aforementioned chief process engineer and cost reduction engineer. Others may be added.

The priority assignments are usually influenced favorably if the new equipment is absolutely necessary to stay in business, or if the return on the investment is outstanding. Other considerations include consequences of not buying it, the future of the product, possibility of equipment obsolescence and ordinary shop judgment.

How We Regard Replacement Formulas

Since factors other than the results of a formula computation enter into the picture, it would be well to explain the attitude of many of our staff and operating personnel toward the use of formulas in machinery and equipment replacement.

To those in the shops, it seems so simple that equipment has to be replaced before it falls apart. They have known it for many years. They knew it before the Machinery and Allied Products Institute. They knew it before Univac. But, since it was so simple, they failed to consider that to the top management the need for replacement was not nearly so obvious. The shop foreman waved his arms and talked in terms of loose gibs, backlash in screws, chatter in spindles, and the accountant talked in terms of conservation of working capital, retirement of indebtedness, return on investment. They could hear each other all right but they were not communicating. Besides, they were a little suspicious of each other.

We have seen in the M. A. P. I. replacement formula and in the many adaptations which have developed from it a new tool with a number of very important advantages. These formulas are effective because:

1. They take factors which the shop can understand, such as the cost of overhauling, price of the new equipment and the increased number of pieces per hour, and translate them into accounting terminology, which can be used to sell the need for the equipment. (We strongly feel that the forms and formulas should be kept simple, and in shop terms.)

2. By demanding an orderly and systematic consideration of all factors which have a bearing on whether or not a tool should be replaced, they make sure that nothing is overlooked in arriving at a decision.
3. The final document has a certain air about it. It appears to have been (and has been) worked out by experts; and it is a well-known truth at the shop level of the manufacturing business that whatever is contrived by an expert (ordinary man away from home) is ever so much more acceptable than data produced by the regular staff, even though it is the same information, paraphrased into longer words and artfully bound in hog leather. This approach helps *sell* the request.

Off-Formula Considerations

There are also a number of shortcomings which we have encountered, and these are worth mentioning. None of the replacement formulas which I have seen gives any consideration to the company's cash position. This factor is usually dismissed as another matter altogether. Unfortunately, it is not another matter.

Consider the situation in which the top management personnel of a large firm became so infatuated with the M. A. P. I. replacement policy that they looked at it as the answer to all problems. Just feed in the information for all pieces of equipment and then start buying in the order of greatest advantage. They painstakingly analyzed several thousand pieces of equipment and concluded that they "could not afford not to" buy $12,000,000 worth of equipment. However, to actually do so would have been disastrous. They settled for $2,300,000, and ended up with very satisfactory progress.

The selection of the particular piece of equipment to be replaced is not as simple as is sounds. You cannot merely select the one which shows the greatest "paper" advantage. For instance, our management believes that a well-equipped tool room is essential to the manufacturing business, not only for the service it performs but because it is a training institution for mechanical skills and future supervision. Yet it is difficult, under most replacement formulas, to make a good case for a tool room machine, for reasons which are entirely obvious to those who have ever tried to fill in the replacement formulas.

Another common case which departs from the strictly arithmetical determination is one where Machine A shows a much better return than Machine B which is on its last legs and, whatever you are making, cannot be made in any other way. Obviously, you buy Machine B so that you can continue to ship your product. (Sometimes, the selection is a matter of trying to guess which of several patients will expire first.)

Another area of considerable legitimate difference of opinion lies in the trends of the business. It is one thing to carefully work out an analysis based on a known work volume which is considered to be fixed and predictable but, in a diversified business, such as ours, we have to be flexible. Often, we cannot predict our future business in terms of exact numerical values, and the machine selection must be made on the basis of guessing where the expenditure will do the most good. Call it business sense, intuition, feel of the market or anything else you like, the fact is that the prosperous business is one whose management guesses right oftener than it guesses wrong.

An example of the uncertain areas you have to evaluate involves our recent acquisition of a 4,000 ton press at a very substantial cost. We manufacture, among other things, truck side bars—the channel-shaped members which form a truck chassis. We had only one press capable of forming these parts and we had customers to whom we were the sole source of supply. These customers were concerned over what would happen to them if our one and only press went down, and rightly so. We were a little nervous ourselves. In this situation, we felt that, while there were certain tangible returns on the investment, such as a moderate increase in business volume, the intangible considerations outweighed anything which could be put on paper in cold figures. If we had not provided the necessary equipment to furnish reasonable assurance of continuous production, some of our customers might have acquired second sources of supply, resulting in loss of business to us. These are the areas in which you must use judgment.

Of all capital expenditure appropriations we issue, not over 40 percent are supported by replacement analysis. We use it only if we can get reasonably factual data to back up the figures. We would rather use the device where it will work and we can defend its mechanics. Where the data is largely intangible, we prefer to say so. However, where there are only one or two significant variables, we sometimes work out the analysis on two bases, one of them with optimistic assumptions, the other with a dimmer outlook. Having both results gives us a better clue as to the desirability of the proposition.

Another consideration is more obvious. The answers yielded by use of replacement formulas are only as good as the data put into them. Our experience is that the input can, within limits of a reasonable degree of sincerity, be juggled to produce a wide range of answers. Trying to assign numerical values to such unknowns as the expected future maintenance of new types of equipment or trying to anticipate the degree of market participation which a new product will enjoy is, at best, guesswork. I hope that we will not attempt to run our busi-

ness too much by computers. A solid knowledge of past performance is more reliable here than hazy guesses on the future.

It is a widely accepted accounting concept that machines become increasingly costly to maintain until, finally, the burden is overwhelming. Often, we see such examples in formulas which have been worked out for demonstration purposes. Surprising as it may seem, we have convinced ourselves on several occasions, one of which was a painstaking analysis of over 600 machine tools, that the curve is likely to slope in the other direction. Our finding is that during the first year of the machine installation, while the "de-bugging" is going on, the "maintenance" costs are very high. We find that through the years, except for occasional lumps of cost which result from planned major overhauls, we tend to spend less and less on the machines, until finally the "old cripples" cost us nothing to maintain. Even without benefit of the formula, it becomes obvious that working on them would be a fruitless expenditure, similar to giving oxygen to a corpse.

Our position can be summarized as follows: A formula replacement policy is highly desirable because it forces orderly and complete consideration and because it presents a picture which can be understood in financially minded circles, even though the individuals who finally say "yes" or "no" might not recognize a Warner & Swasey, if they found it in their soup. While the replacement formulas are not perfect and not foolproof, they are by far the best tool available to us today. There is little doubt that in the future they will be even better, and more widely used. Even if replacement formulas are superseded by better methods, they have rendered a distinguished service by calling to the attention of industry and its financial supporters the perils of allowing the tools of production to become obsolete, which in peacetime can lead to stagnation of industry and in wartime to complete disaster.

Review at the Corporate Level

The next key feature to our plan is the establishment of a capital budget review committee composed of the vice president of manufacturing, corporation controller and the chief engineer. This committee visits each division during the third fiscal quarter and reviews each project as sequenced on the capital project control card.

This review occasionally causes the elimination of certain less desirable projects and frequently causes a change in the priority sequence. Sometimes, substitutions from a surplus equipment pool are proposed. When the study is completed, the committee makes certain that all changes are recorded on both copies of the capital project control cards, and returns to the general office with one

set of the cards. No commitments have been given to the division, but a tally of the cards indicates the total dollars desired. When all visits are completed, the committee knows the maximum total desired by all units. It proposes then, in total, a preliminary corporate capital budget for the coming fiscal year. Since this is done before the development of formal shipment and profit planning, it is necessary to apply judgment to the determination of the profit picture. Basically, the planning follows these lines:

Net profit after taxes		$10,000,000
Less — Dividends	$3,000,000	
Loan payments	1,000,000	4,000,000
		$ 6,000,000
Plus — Depreciation		6,000,000
Maximum available		$12,000,000

The $12,000,000 could be increased by borrowing money or even by floating stock or bond issues if the incentive is great enough. In actual practice we hesitate to use the whole amount because if we do and profits drop we are squeezed in to a borrowing situation. Perhaps the limit recommended will be $10,000,000 or $11,000,000. Invariably, it will be in excess of the amount to be provided by depreciation.

Whatever the limit, it probably will be less than the total of the requirements of all divisions. The next step is to allocate it to the twelve divisions requesting funds. Since we are not only reinvesting the earned depreciation but also investing a portion of the profits retained in the business, it is vital that the dollars produce a return which will not only equal current yields but also achieve the increased return anticipated in our forward planning. With this in mind, as well as the return or advantage expressed on the individual control cards, the committee removes cards until the divisional requirements equal the agreed total. A proposal for total and divisional budgets is submitted to the executive vice president for approval.

Assuming the budgets are approved, the executive vice president gives the data and the control cards to the management controls and operations analysis department. This department promptly informs the division managers of the approved totals, along with advice that the amounts are approved in principle only and that the divisions are authorized merely to submit capital projects for final consideration. The divisions may also use the approved amounts for their formal forward plan for the coming year. This plan is due in the fourth fiscal quarter.

Appropriation Procedures

From this point on, the management controls and operations analysis department is the focal point for control of projects, appropriations and actual expenditures. This department is a part of the staff of the controller and serves the executive vice president as a center of information and control of the various areas of budget, forecasts, forward plans and actual results concerned with shipments, profits and capital programs.

Upon receipt of the approved totals, and coincident with the submission of the formal forward plan, the division managers may start to submit specific capital project requests for approval. Significant points in the operation of the system are:

First, project request forms, in duplicate, are submitted for all programs of expenditures. These forms are originated by the chief engineer of the division, processed by the facilities clerk in the accounting department, approved by division manager and forwarded.

Second, appropriation request forms are submitted for specific items within an approved program (project).

Third, if the project covers just one item, such as a 100-ton press, only one approval is required and the form so marked.

Fourth, a number is assigned (example—289-NR—1), and inclusion in capital budget is verified.

Fifth, if trade-in is involved, the project value equals cash outlay:

Cash required	$_____
Net book value of trade-in	_____
Capitalization value	$_____
Net list price of new asset	_____
Memo gain or loss	$_____

Sixth, where a project or appropriation request pertains to machine tools, capital production equipment, plant facilities and buildings housing manufacturing areas, and transportation equipment, or major renovations of any of these items, the request is sent first to the machine tool and equipment committee. This committee, composed of the facilities purchasing agent, the manager of the tool division and two staff members of the vice president of manufacturing, evaluates the specific item to see whether the investment is justified and whether we are buying the best item at the most attractive price. This group has the experience of many years of living among machine tools. Its function is to

see to it that we get the best machine at the best price and that the investment is justified. In many cases, these individuals go back to the division for more information. They might suggest the names of other possible choices. They might question the process involved or any other factor which might have a bearing on the matter.

RECORD OF COSTS AND SAVINGS ON CAPITAL EXPENDITURE PROJECTS

DATE

DESCRIPTION OF PROJECT (APPROPRIATION REQUEST FOR NR PROJECTS) | PROJECT NO.

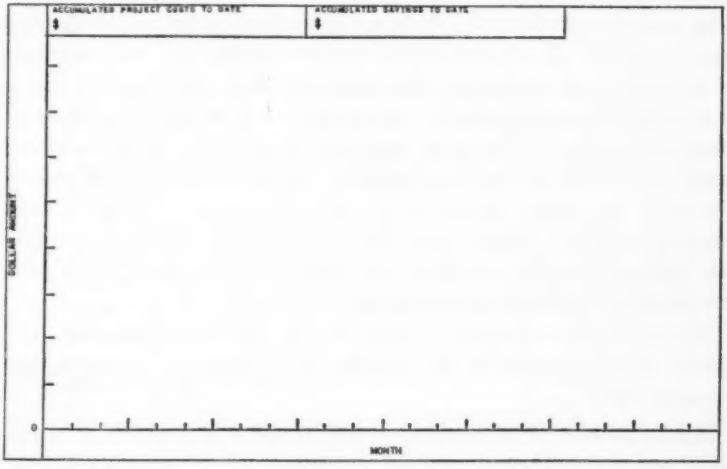
DATE OF PROJECT OR APPROPRIATION APPROVAL

ACTUAL NET SAVINGS GAINED TO DATE (Yearly Basis) (Unfavorable amounts to be reported in red)	ACTUAL NET SAVINGS
Wages - Hourly Personnel	$
Salaries - Salaried Personnel	
Employee Benefits and Premium Payments	
Reduction in Scrap	
Maintenance and Repairs	
Other (Explain)	
TOTAL ACTUAL NET SAVINGS (Yearly Basis)	$
ORIGINAL ESTIMATED SAVINGS	$

Planned Production Volume per Original Project Request (Yearly Basis)_____

Correct Actual Production Volume (Yearly Basis) _____

Date Standards were changed (If any) _____



INSTRUCTIONS:

On the chart above, plot (as horizontal lines) the amounts of the original project approval and the estimated saving. Then plot the actual accumulated costs and the accumulated savings on this project.

The scale of the horizontal axis is marked off by month while the vertical axis is not designated.

Dollar amounts for the vertical axis will be determined by the submittor.

EXHIBIT 2

MONTH	DATE ISSUED	MONTHLY CAPITAL					
			PROJECTS				
NUMBER	DESCRIPTION OF PROJECT	COMPLETION DATE PLANNED	FORWARD PLAN THIS YEAR	APPROVED PRIOR YEARS	APPROVED THIS YEAR	INCREASED OR DECREASED	TOTAL APPROVED
	NORMAL REPLACEMENTS – PRIOR YEAR		XXX		XXX		
	NORMAL REPLACEMENTS – THIS YEAR – TOTAL PLANT AND EQUIPMENT DIES, JIGS, AND FIXTURES DURABLE TOOLS						

INSTRUCTIONS: LIST ALL PROJECTS (IN NUMERICAL SEQUENCE) EXCLUDING NORMAL REPLACEMENTS, GROUPED BY CLASSIFIC

EXHIBIT 3

An important function of the committee is to keep posted on all idle equipment around our plants and to see that such idle equipment is put to use instead of purchasing new equipment. It is surprising what can be done in this area alone. Sometimes equipment is down-graded. For instance, if a repair shop wants a new lathe, the committee might arrange for an old but still serviceable machine out of our tool room and purchase a modern machine for the more precise work. Or, suppose that our electric motor plant puts in a highly automatic setup which frees a number of semi-automatic machines. In such a case, a three way exchange might be arranged through which a unit still using strictly manual equipment will receive the semi-automatics.

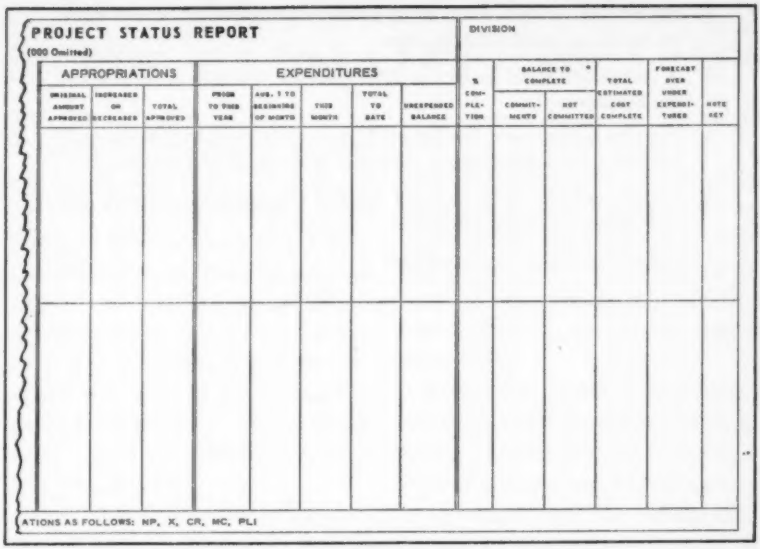
Seventh, if office equipment is involved, the systems department checks the request against a surplus list and considers the suitability of the equipment for the application.

Eighth, projects are reviewed by controller and vice president of manufacturing and approved by executive vice president.

Ninth, the department controls progress of approvals.

Reporting

In addition to the approval sequence described above, there are two follow-up



PROJECT STATUS REPORT
(000 Omitted)

DIVISION

APPROPRIATIONS			EXPENDITURES					% COMPLETION	BALANCE TO COMPLETE		TOTAL ESTIMATED COST COMPLETE	FORECAST OVER UNDER EXPENDITURES	NOTE KEY
ORIGINAL AMOUNT APPROVED	INCREASED OR DECREASED	TOTAL APPROVED	PRIOR TO THIS YEAR	AUG. 1 TO BEGINNING OF MONTH	THIS MONTH	TOTAL TO DATE	UNEXPENDED BALANCE		COMMITMENTS	NOT COMMITTED			

ATIONS AS FOLLOWS: NP, X, CR, MC, PLI

EXHIBIT 3 (Cont'd)

divisional reports submitted to the management controls and operations analysis department:

1. A Record of Costs and Savings on Capital Expenditure Projects (Exhibit 2) is submitted each quarter. This report is significant, not only to follow-up approved projects but to guide the capital budget review committee in its evaluation of a particular division's future proposals.
2. Each division submits a Monthly Capital Project Status Report (Exhibit 3). This complex form provides the data for the department to analyze and summarize the status of projects and expenditures. Concise summaries are submitted to the executive vice president.

Key Features of the System

To summarize, there are seven key features in our capital expenditure review and control system:

1. Capital planning begins at least one year prior to the fiscal year in which the expenditure will be made.
2. Requirements are recorded on capital project request control cards and sequenced as to priority by the division.

3. An on-the-spot review is made by the capital budget review committee in the third fiscal quarter.
4. A corporate capital budget is developed and the total is allocated to the divisions.
5. Projects are screened by the machine tool and equipment committee which uses replacement formulas as a means of justification.
6. Control activity is performed by the management controls and operations analysis department.
7. Follow-up reporting is required.

Rate-of-Return Verification by Follow-up Reporting on a Project Basis

by ROBERT K. JAEDICKE

IN THE LAST FEW YEARS, much attention has been focused on the investment-decision process. What should the firm do by way of reporting the results of these decisions on a historical basis? Also, what are the purposes to be served by a program of follow-up reporting or post-audit of investment projects? This article is concerned with both of these questions. By way of reporting, the particular concern is with follow-up reporting on a project basis.

One method of reporting the results of capital investment is through the traditional statement of net income, computing a rate of return on invested capital by relating the reported net income to some measure of investment as taken from the balance sheet. Probably every business firm does at least this much by way of historical reporting.

There are several problems connected with this procedure but the one basic difficulty is that profit is affected by many variables, not just by the investment of capital. The effect of capital investment is not isolated; it is simply one of several variables which could cause a change in net income from one accounting period to the next. Furthermore, the rate of return computed by this "aggregative" approach is affected by capital invested over several past periods; capital invested in recent periods may have very little weight in the overall rate-of-return index.

A variation of historical profit reporting has recently received much attention in controlling operating divisions of a decentralized company on a rate-of-return basis. The striking characteristic of this method of control, as opposed to the usual profit control of an operating division, is that investment is also assigned to the operating division and a rate of return is computed. This rate, much like that discussed above, helps to focus attention on and thus furnishes some control of capital investments.

Another method of control or follow-up on capital investments is to report on the project (or a group of projects) instead of reporting on some organizational unit. This is a "micro" approach as opposed to a "macro" or "aggregative" type of reporting. The

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focus of attention is on the capital investment *per se* and an attempt is made to isolate the effects of the investment. The primary emphasis here is to answer the question, "Did the actual performance of the capital acquisition live up to the estimate?" If individual projects are selected on a time adjusted rate-of-return basis, the post-audit or follow-up attempts to verify the rating that was calculated for the project.

Objectives of Follow-up Reporting on a Project Basis

It seems that there are at least three important advantages or objectives of follow-up reporting:

1. Provide information for decision-making.
2. Serve as a basis for corrective action.
3. Stimulate the realization of investment program goals.

If a reporting system does not accomplish at least one of these objectives, its value to a company is probably low. The three objectives are discussed below.

A system of follow-up reporting might provide information which can be used to make decisions or lay plans for a future period. Information on how recent projects have turned out may be a real aid in evaluating future projects. Companies may have repetitive investments. For example, the decision may arise every few years as to whether a fleet of automobiles should be purchased or leased, or a program of equipment replacement or modernization may have been undertaken over a long period of time. Certainly, it would help the management in the repeat decision to know how past similar projects have worked out. Furthermore, even if similar decisions are not made on a repetitive basis, follow-up information may be of value. It may be very important to calibrate the forecast against the results to see whether a particular analyst shows a predominant bias toward over or under-estimating. If this is the case, management may wish to make adjustments on future analyses event though the new projects are quite different from past projects.

A system of follow-up reporting may provide information which will help pinpoint a bad situation and serve as a basis for corrective action. If things are not working out as they were estimated, perhaps post-audit will show that additional "debugging" is necessary. It may be that a system of reporting and follow-up will be necessary to show when the review operations can be stopped on a certain project. If post-audit shows that some projects are not working out as expected and corrective action is impossible, this information might also be very valuable. It may be that certain investments have been put on the shelf because these "sour" projects

were more favorable on a rate-of-return basis when the estimates were prepared. If follow-up shows big deviations from the estimates (even if corrective action is out of the question), it may be that the opportunity rate of return being used by the management is too high, that is, management may be keeping projects on the shelf which should be undertaken.

A third objective which may be served by a reporting system is to stimulate the personnel of the organization to keep their eyes on the goal and to progress toward this goal. The post-audit should serve to remind the production and research and development people that the analyses or estimates were not just a collection of useless facts or a guess at what will happen in the future. The post-audit should help make the estimate a program or a goal and challenge the personnel to realize this goal.

Some Problems of Investment Follow-up; Assumptions and Estimates

Having set forth the objectives or purposes of a program of post-audit on a project basis, the important question is, can these objectives be met? Even though the objectives are highly desirable, there is no justification for establishing a reporting system if it fails to meet the test of usefulness as set forth above. With these standards of usefulness in mind, some of the important problems connected with post-audit will now be discussed. For purposes of discussion, the following example will be used. The project to be evaluated or audited is an equipment-replacement project. The original estimate was as follows:

	Old Machine	*New Machine*
Investment—purchase price plus installation of the new machine		$50,000
Scrap value of the old machine	$ 1,000	
Annual labor cost	15,000	10,000
Annual product improvement if the new machine is purchased		4,000
Annual improvement in safety if the new machine is purchased		5,000

Estimated life—10 years Estimated annual volume—100,000 units
Approximate time adjusted rate of return 25%

The purpose of the post-audit is to see if the actual rate of return is as was estimated, i.e., 25 percent.

A basic and important problem encountered in post-audit is that, in order to verify the rate of return, an estimate would have to be made of what would have happened if the new machine had not been purchased. The rate of return (or the payback factor for that matter) is calculated by comparing the new process with the old process. Consequently, to fully audit this rate, the old as well as the new process should be audited. The audit of the process or machine which was not accepted is an estimate in the sense that the company has no actual experience. There is no reason why the company would know more about the rejected project one year from the date of the estimate than it did when the estimate was made. If more information does exist, it must be brought into the audit.

With reference to the example, if the labor cost of the new machine during the first year of operation turns out to be $11,000, a determination must be made of whether the $15,000 annual labor cost of the old machine would have changed. If the $1,000 change in the new machine cost was caused by a change in wage rates, the $15,000 labor cost of the old machine should probably be reviewed and adjusted. If the $1,000 difference results from technical difficulties, perhaps no adjustment need be made in the estimated labor costs of the old machine. Note, however, that the cost assigned to the old process is an estimate; consequently, the "audit" of the rate of return is subject to uncertainty and error.

This same problem has other aspects. How can the decline in scrap value of $1,000 on the old machine be verified? How does the auditor confirm that the life of the old machine, in fact, would have been 10 years? If it is not possible to do much in the way of review, it is probably necessary to assume that the old process would have been performed according to the original estimate. Such an assumption may be very poor in a good many instances. At best, the resulting post-audit is still very much an estimate rather than a certainty verification.

Assume that the old process would have performed according to the original estimate. Given this assumption, what are the problems encountered in the audit of the new process? With reference to the above example, how can the amounts assigned to product and safety improvement be audited? It is probably true that in the case of many investment projects, dollar amounts are assigned on the basis of careful judgment rather than rigorous quantitative analysis. Even if these judgment factors are not included, an amount, *zero,* is assigned. How can these judgment factors be audited? Once again, an important part of the audit may be a careful estimate or review of the analyst's judgment. Even if safety statistics are available, what

is involved in the way of time and cost to review these statistics in the formation of a judgment as to the "actual" rate of return?

At this point, an interesting question arises. If investment projects are subject to post-audit, will this cause the analyst to leave out the advantages of the new process that are difficult to quantify and verify? Such a situation would be rather unfortunate; there is nothing magic or good about a conservative estimate if it is really an understatement, nothing which would make an understatement any better than overstatement. Any system of post-audit must be flexible enough to take this difficulty into account. Any procedure of post-audit must not simply be a process of making tick marks but should be a careful, perhaps narrative, review of what has happened.

Another important problem is when and over what time period the audit should be done. Complete vertification would require a follow-up on the project throughout the economic life. This would probably be very costly, difficult, and tedious and there may be no real advantage to be gained to offset these objections. On the other hand, the economic life is a very important determinant of the time-adjusted rate of return.

Post-audit may well be most valuable during the "debugging" period. The purpose of such an audit is more to facilitate complete installation and help work out technical problems than to verify the return on the project. In order to assess the return, it is probably necessary to audit at least one operating period beyond the date on which installation and preliminary testing have been completed.

There is also a problem of who should do the audit or follow-up. If the audit is used to evaluate the analyst, someone other than the analyst should probably do (or at least review carefully) the work. On the other hand, the analyst may be the person closest to the project and he may be able to do an effective follow-up report with the least cost and effort. This decision may well be very important in the installation of a follow-up system.

If the actual volume realized during the audit period is different from the estimated volume, which should be used in judging the rate of return? If the actual volume is used (assuming a difference), certainly some adjustment is called for in the original estimate on the old process. It seems obvious that the actual volume should be used although Terborgh makes a fairly strong case for (and seems to prefer) using the estimated volume. He says that the assumed rate should be used because ". . . the question is how well he (the analyst) predicted the advantages from the project under review at the operating rates assumed."[1] His primary justification for

[1]George Terborgh, *Business Investment Policy*, Machinery and Allied Products Institute & Council for Technological Advancement, Baltimore, 1958 p. 146.

this position is that the analyst is furnished the operating rate by the front office so they must share the responsibility for any error caused thereby. This position is good if the audit is to be used to evaluate the analyst; for most other objectives an audit based on actual rates would be more effective. If post-audit is used, where will the data and information come from? Accounting records are generally not set up to report on individual projects. A special study, using the accounting records, may be expensive and time consuming. Furthermore, the problem of isolating the effects of a given investment project may make follow-up impracticable. What is the effect, for example, of the improvement of one product on the sales of other products handled by the company? What is the source of this sort of data?

Deficiencies of the Follow-up System

It seems to me that accountants are sometimes too quick to advocate follow-up reporting as an absolute necessity regardless of what is being reported on. The important objectives that must be met by a program of investment follow-up have been set forth in some detail. Some of the problems in accomplishing these objectives have also been described. It is difficult to generalize but there are some real doubts as to whether the objectives can be met, as the following summary statements indicate:

1. Post-audit or follow-up of investment projects is not as accurate a procedure as the word, audit, implies. The procedure is still filled with estimates, assumptions and uncertainty.
2. A procedure of follow-up is probably most useful as an aid in "debugging" the new process, rather than as a goal to the production people or as a procedure for providing planning information about future projects.
3. Before a system of follow-up is installed, the accountant should be quite specific on the objectives to be met by the system. The system is justified only if the resulting information is useful. There is no reason for reporting interesting facts to satisfy idle curiosity. If the cost of the system is high and the information of below-average usefulness, follow-up on a project basis is not the answer.
4. Certainly post-audit should not be used as a substitute for a complete and rigorous analysis of projects before they are undertaken.

A Glimpse at Practice in Calculating and Using Return on Investment

by JAMES H. MILLER

ALTHOUGH MANY ARTICLES have dealt with return on investment, management still questions how extensively this concept is actually being used in business today. This paper is intended primarily to answer this question by presenting the results of a survey of companies rated as well-managed. In order to derive the most value from the survey, we will, first, briefly describe the methods of calculating return on investment and the business applications in which it is used and, secondly, analyze in detail the replies from 127 well-managed companies.

Methods of Calculating Return on Investment

Payback is calculated by dividing the total investment by the sum of profit per year after taxes, plus depreciation. The results are expressed in number of years. Advantages: (1) ease of calculation, (2) management can be sure its funds are not tied up very long in one venture involving heavy risks and (3) during a period of cash stringency, a short payback may be more necessary than total profitability. Disadvantages: it does not take into consideration (1) the life of the investment and (2) that profits vary from year to year. Payback has been primarily used in evaluating new capital. It is still useful as a quick check or a guide but does not give adequate information for management to make a final decision on how new capital funds should be invested.

Discounted-cash-flow method has come into prominence only recently for use by industry in evaluating capital outlays. In order to calculate return by the discounted-cash-flow method, it is necessary to project the profits for each year throughout the expected life of the assets purchased. The rate of return is the discount percent at which net profit after taxes plus depreciation (for the entire life of the asset) discounted yearly, according to present worth, equals the project's cost. Advantages: it takes into consideration (1) the length of the project's life, (2) that money is not worth the same in the future as the

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dollars are today (It values projects with high earnings in early years differently than projects with low earnings early and high earnings later in the project's life.) and (3) it allows one to reflect different depreciation rates which change the cash flow. Disadvantages: (1) it is more difficult to calculate than any of the other methods and (2) it is useful for projects involving new capital expenditures but cannot resolve many of the other problems as discussed further on in this article.

Return on investment formula. The basic formula is as follows:

$$\text{Return on investment} = \frac{\text{Net profit}}{\text{Sales}} \times \frac{\text{Sales}}{\text{Investment}}$$

or

Return on investment = Percent profit on sales x Capital turnover.

This formula recognizes that return can be affected by either greater or lesser turnover of investment, or by an increase or decrease in profits or sales. Using this basic formula there are various ways of calculating return on investment. Advantages: (1) it is easy to calculate, (2) it can be used for a greater number of applications than any other base and (3) it is more easily understood than discounted cash flow. Disadvantages: (1) it does not consider the life of the project when evaluating new capital, (2) it does not discount future dollars and (3) it does not take into consideration that profits vary from year to year.

Some comments regarding the different investment bases which are used are as follows:

1. Total assets at book value:
   a. This is the total investment in a business at any time, either by owners or creditors; therefore, it may be the more proper base on which to check return.
   b. Since it is the same as shown in the statements, management's time is not consumed discussing the validity of the base.
   c. It is easier to compare with other companies.
2. Total assets at original cost:
   a. When measuring internal profit, this is an atempt to iron out some of the differences between value of old assets, as compared with new assets, caused by the use of book value.
   b. It doubles up on depreciation to some extent, since cash created by depreciation on assets is still in cash, or has been used to purchase other assets.

3. Total assets at estimated replacement value:
   a. This is another attempt to eliminate differences in value due to age of the asset.
   b. Total investment is overstated.
   c. Replacement values are estimates and are always subject to question as to their correctness.
   d. Replacement values are difficult and sometimes expensive to calculate.
4. Total assets less current liabilities (This is being used as a separate category; however, it can be applied to each of the above.):
   a. Current liabilities are sometimes deducted because they are a normal source of short-time funds for any business, and are not considered a part of the investment base by some managements.
   b. This does lessen the investment base and fails to recognize that it is just as important to earn money on the assets available through current liabilities as through stockholders' investments or long-term lenders.
5. Net worth:
   a. This investment base is important to owners and is probably derived from the measurement of stock value on the earnings per share.
   b. It again fails to recognize that, to measure profitability or management, one must consider how well total investment was utilized, not just that portion of it which is provided by stockholders.

Major Uses or Applications of Return on Investment

Return on investment is not limited to a single application in business. This concept has been used successfully in many ways; some of its applications are explained here.

ANALYZING NEW CAPITAL EXPENDITURES BEFORE AND AFTER

One of the major problems confronting management today is how and when new capital should be invested. Future profits of each company depend on wise investment decisions today. There are three phases of the problems in which return on investment can be used to aid management:

1. In capital forecasting. The forecast should be prepared and submitted by the individual profit centers or divisions, at least for one year in advance. Each project should be shown separately with a preliminary engineering estimate of its cost and the reason for

recommendation. Any project which is recommended as cost savings or for additional sales and profit would also include a calculation of return on investment. With this forecast, management can formulate a realistic plan of action for the future, taking into consideration the profits and cash flow expected.

2. Prior to committing the company for any expenditure on a project, a formal appropriation request should be submitted to management for approval. This request would have a detailed engineering estimate of cost of the project. The profit center should also have made a full study of the return on investment expected on the project, if applicable, and include the expected return as reason for approval. The estimates of cost and return included on the appropriation request should be as nearly accurate as possible because management in the profit center should be held responsible for meeting these estimates.
3. The third phase is checking the performance after a project is complete where a cost saving or additional sales and profit were indicated. Here again, return on investment is the measuring stick. Return was used to sell the project to management, so actual return should be compared with the anticipated return indicated on the appropriation. When profit center management knows that actual results of capital expenditures will be compared with those given on the appropriation request, one can expect better estimates on which to approve or reject a project.

INTERNAL PROFIT MEASUREMENT

Management recognizes that there are many factors which affect profits and that there is no one measure which does not require further analysis; however, most agree that the best single yardstick to measure internal performance is return on investment. Good internal profit measurement requires that the accounting system be designed to properly reflect profits by each profit center. Allocations become a problem, and some recommend that corporate management and home office charges should not be allocated to divisions while others feel it is necessary to allocate, since failure to do so would likely cause division returns to be higher than total corporate figures. Since we are primarily looking for trends in returns, the failure to allocate home office charges should not affect the value of using the return for internal measurement.

EXTERNAL PROFIT MEASUREMENT

External profit measurement is an analysis of a company's performance with that of its competitors and other well-managed companies, so it is necessary to use assets, as shown in the financial statements, as the investment base. A sim-

ple comparison of the company's return this year with outside companies is not adequate; the trend and how this return was earned must be checked.

In checking trends, we should make a dual comparison for a number of years of after tax profit and before tax profit. For these years we should analyze how the return was earned. Return is net profit on sales multiplied by investment turnover, so we must check each component to determine where our return differs from other companies, especially competitors. How does our return on sales compare? Check as deeply into the income statements as possible to determine why our return differs. Is it the cost of sales, selling expense, administrative expense, etc.? In turnover, we should check each classification of assets in relation to the volume of sales. Are our inventories in line with our sales volume, how about our fixed assets, etc.? One must realize that the vertically integrated company would have higher fixed assets in relation to sales than the non-vertically integrated company. This should be offset by lower cost of sales in relation to sales volume.

The previous paragraph indicates how valuable such an analysis can be in pointing out areas in which improvement is necessary but return is only a tool which helps to point out deficiencies and strong points, and it is up to management to take the necessary steps for corrective action.

SETTING PROPER PROFIT GOALS

In preparing short and long-range forecasts, how does one determine what profit goal is adequate or necessary? If there is any agreement that return on investment is the correct measure for internal profit measurement and comparison with outside companies, then this must be the same yardstick we use in setting our profit goals for the future. As indicated previously, we should have analyzed our own and our competitors performances, determined trends and located existing differences. It would seem that with this information we already have the basis for future planning.

MEASUREMENT FOR MANAGEMENT INCENTIVE PAYMENTS

Determining a proper base for incentive payments for management is a very difficult problem. The prime motive of each business is making a profit and the motive for investing money in business is to obtain a return on the investment. Return should be one of the considerations for incentive payments; however, management should recognize the following objections to weighing this factor too heavily:

1. The effect on profit of external factors beyond management's control.

2. Short-run profits (one year as shown in statements) versus long-run profits.

MAKE-OR-BUY DECISIONS

Make-or-buy decisions often involve additional capital equipment and, if so, they should follow the same procedure in analyzing capital expenditures as outlined previously. In many cases, new capital equipment is not involved, but we cannot assume that no additional investment is required. We can normally expect working capital to increase, and the return should be calculated on the additional investment in working capital.

LEASE-OR-OWN DECISIONS

Lease-or-own decisions are quite prevalent today, especially in the chain retail field. This is another excellent example of the type of situation in which return-on-investment concept can be valuable. The cost of leasing, less the cost of owning, related to the investment necessary, is an excellent tool for management to use in deciding whether an investment is more desirable than leasing.

AS A GUIDE TO INVENTORY VOLUME

The return on investment formula may be useful in determining volume of inventory under any of the conditions involving (1) purchases from suppliers on which different unit prices are available on different quantities, (2) sales to customers which are permanently lost if not serviced from inventory or (3) the balancing of production schedules and inventories. The usual formula return is modified as follows:

Return on change in investment (or inventory)	=	Rate of savings or profit after tax	x	Turnover of the change in average inventory involved.

This formula must then be applied to the different possible levels of average inventory. To do this with any large number of items would be very time-consuming and, since prices and conditions are by no means static, it is questionable that it would be economical, except for major items in the inventory.

AS A GUIDE IN EXTERNAL PRICING

Pricing problems are continually facing management and, to make proper pricing decisions, some yardstick is needed. Since return on investment is considered a good measure of management's performance, the proper price would be one which yields the return expected of management. It does not mean that the final price will always be one which yields the desired return by the firm.

This will depend on market conditions at the time the price is established. The return on investment may prove helpful to management in some pricing situations, such as, for instance:

1. Pricing new products the price of which is not entirely governed by competition.
2. Pricing present products to cover additional manufacturing costs or increased asset replacement cost.

AS A GUIDE IN INTERNAL PRICING

It is generally agreed that internal prices should be the same as prices to outside markets for items with established selling prices. However, there are many items and component parts for which no external prices exist. These are the situations in which return on investment calculations aid in proper pricing among divisions or profit centers of a company. The price established should allow the selling division to earn its normal return on investment.

ANALYSIS OF INVESTMENTS IN OTHER COMPANIES

Analysis of investment in other firms may be necessary due to (1) contemplated acquisition and (2) investment of pension, profit sharing or other funds. Where acquisitions are contemplated, the calculations of return would be of aid in determining the proper price. It should not necessarily be regarded as the expected rate for the future, since the management will normally change, at least to some degree, after acquisition. When funds are invested in stock of a company, prior rates of return can more likely be expected to continue, since management is not expected to change. The rate of return on total assets is quite important here as a measure of management. An additional calculation of the return on net worth is very important, since this is what the investor expects to participate in either as dividends or increased value of investment. Return on the investment of dividends alone is also important if the prime reason for investment is the cash return.

How Well-Managed Companies Use Return on Investment as a Management Tool

A questionnaire was mailed to 200 companies selected from:

1. "Manual of Excellently Managed Companies," published by the American Institute of Management.
2. A list of the 500 largest companies published by *Fortune* Magazine.

In selecting the companies, an attempt was made to choose a diversified list of companies as to size and geographic location. Railroads and public utilities were not included. This questionnaire was sent primarily to companies considered to have excellent management, in order to determine the extent to which better-managed companies use this management tool. Each company was asked if it used return on investment in any way. If used at all, it was asked to indicate the application for which it was used and the method of calculation used for each application.

Replies were received from 127 companies (63.5 percent of companies contacted). A summary of responses is tabulated in Exhibit 1. Of this number, 119 companies reported they used return on investment in one or more ways as an analytical tool. The high percent of companies using this tool is not expected to be representative of business as a whole but only of well-managed business.

Analyzing new capital expenditures prior to investment. Of the total companies replying, 116 use return on investment to evaluate prospective capital outlays. It is not surprising to find return on investment being used more widely for this purpose than any other, since this was the original reason for the development of the concept. In their analyses, there is a tendency for companies to figure investment in more than one way.

As indicated by Exhibit 1, more companies use payback as a method of calculation than any other for this application. It is interesting to note that, even though 66 companies use payback, only 18 (27.3 percent) use this calculation by itself. Of the companies using return for this application 54.3 percent use a single calculation, yet only 27.3 percent of those using payback method use it alone. This would indicate that most companies use payback either as a quick first check or as a second calculation to check another method.

The most popular method of calculation used alone is return on total assets at original cost, with 26 companies using this method alone. Fifteen companies use discounted cash flow alone.

Combinations calculations used included:

	Number of companies
1. Payback and Return on total assets at original cost	18
2. Payback and Discounted cash flow	11
3. Payback, Discounted cash flow and Return on total assets at original cost	10

Checking performance after investment of new capital. Although 91.3 percent of the companies surveyed use return on investment to analyze proposed

TABULATION OF RESULTS - RETURN ON INVESTMENT QUESTIONNAIRE

I. Number of Companies included in the Survey 200

II. Number of Companies replying to Questionnaire 127

III. Number of Companies using return on investment for some application 119

IV. The following analysis shows the number of Companies using this concept for each application and the calculation used for each application:

APPLICATIONS	Number of Companies Using ROI for this Application		Number of Companies using These calculations for each Application (Refer below for Calculation represented by each No.)									
	YES	NO	1	2	3	4	5	6	7	8	9	10
1. Analyzing new capital expenditures prior to investment	116	11	66	38	58	-	-	15	-	1	2	6
2. Checking performance after investment of new capital	90	37	38	16	43	11	2	12	-	1	3	3
3. Internal Profit Measurement (Performance of divisions or profit centers)	96	31	6	-	33	26	4	8	20	4	12	4
4. Total company profit measurement (Comparison with other firms)	99	28	2	-	26	29	3	7	23	1	50	2
5. Setting proper profit goals	76	51	6	4	21	18	6	5	16	4	20	3
6. Measurement for management incentive payments	32	95	1	-	6	5	-	2	7	-	11	3
7. Make or buy decisions	64	63	27	20	18	8	1	6	6	2	-	3
8. Lease or own decisions	71	56	27	28	16	10	-	3	6	2	-	4
9. As a guide on inventory volume	28	99	5	5	6	-	2	1	4	1	3	2
10. As a guide on external pricing	34	93	6	6	8	7	2	2	6	2	2	2
11. As a guide on internal pricing	15	112	6	1	6	3	1	-	2	-	-	1
12. Analyzation of investments in other companies - Example - investment of retirement fund	46	81	8	10	11	8	2	2	2	1	21	4

METHODS OF CALCULATING RETURN:

1. Pay back
2. Discounted cash flow
3. Return on total assets at original cost
4. Return on total assets at book value
5. Return on total assets at estimated replacement cost
6. Return on total assets at original cost less current liability
7. Return on total assets at book value less current liability
8. Return on total assets at replacement cost less current liability
9. Return on net worth
10. Others_____

V. Referring to the calculations under each application in Item IV, you will note the total calculations are greater than the number of Companies stating they use ROI for that application. The reason being many Companies make more than one calculation for a single application. The analysis below indicates to what extent this is prevalent.

APPLICATIONS	NUMBER OF COMPANIES			
	SINGLE CALCULATION	TWO CALCULATIONS	THREE CALCULATIONS	FOUR OR MORE CALCULATIONS
1. Analyzing new capital expenditures prior to investment	63	36	16	1
2. Checking performance after investment of new capital	61	20	8	1
3. Internal Profit Measurement (Performance of divisions or profit centers)	82	9	4	1
4. Total company profit measurement (Comparison with other firms)	62	30	7	-
5. Setting proper profit goals	58	13	3	2
6. Measurement for management incentive payments	29	3	-	-
7. Make or buy decisions	44	15	3	2
8. Lease or own decisions	54	10	6	1
9. As a guide on inventory volume	27	1	-	-
10. As a guide on external pricing	31	-	1	2
11. As a guide on internal pricing	12	2	-	1
12. Analyzation of investments in other companies - Example - investment of retirement fund	33	8	1	4

EXHIBIT 1

investments, only 78.0 percent attempt to follow through and check the actual return obtained on these investments and a number of them indicated they are just beginning to check performance. This is an application the use of which is increasing. Many companies will find it profitable to use return on investment and find out whether the returns estimated prior to investment are actually being realized. A much higher percentage of companies use a single calculation in checking performance than in analyzing an investment before investing.

Combinations used most often were as follows:

	Number of Companies
1. Payback and Return on investment at original cost	9
2. Payback and Discount cash flow	3
3. Payback and Return on investment at book value	3
4. Payback, Discounted cash flow and Return on investment at original cost	5

Internal profit measurement. The survey revealed that 85.4 percent of the companies using return on investment for appraising internal profit levels use a single calculation. The purpose here is to measure performance of divisions of the business, and it is important that the persons responsible for each area understand how they are being measured. This is probably one of the most important reasons for the use of a single calculation. One company stated that it considers return on investment as the best single measure of the performance of existing facilities.

External profit measurement. Return on investment is used by 99 companies to compare their company's performance with that of competitors and other well-managed organizations. For this application a large number of companies use multiple calculations.

Combinations of calculations used most often were as follows:

	Number of Companies
1. Return on total assets at book value and Return on net worth	8
2. Return on total assets at original cost and Return on net worth	7
3. Return on total assets at book value less current liabilities and Return on net worth	5
4. Return on total assets at original cost less current liabilities and Return on net worth	4

It is significant to note that more companies use return on net worth to compare profits externally than any other method of calculation. Of the 50 com-

panies which use net worth as the investment base, only 19 use it as a single calculation. Most companies apparently consider net worth important but, at the same time, recognize the importance of return on total investment.

Setting proper profit goals. Seventy-six companies indicated that they use return on investment for the purpose of setting profit goals. Most companies use a single calculation. The companies using multiple calculation do not follow any pattern. Although fewer companies use return on investment for this application than for internal profit measurement, almost all companies using this tool for both, use the same method of calculation for both applications.

Measurement for management incentive payments. Only 32 companies indicated that they use return on investment for calculating incentive amounts for management personnel; twenty-nine of them use a single calculation. This would be expected since individuals should know how they are being measured for incentives to be effective and more than one calculation would only confuse the issue. The number of companies using return on investment for this application compared to the total companies replying can be misleading since the questionnaire did not ask whether the company has a management incentive program.

Make-or-buy and lease-or-own decisions. The usage of return on investment follows the same general pattern for both make-or-buy or lease-or-own decisions. Seventy-one companies use it for lease-or-own decisions and 64 companies use it for make-or-buy decisions. The greater number of companies using return on investment for lease-or-own decisions would be expected from the sample since some of the companies surveyed were retailers.

The use of a single calculation is predominant in both instances. Of the 64 companies using return on investment for make-or-buy decisions, 44 use a single calculation. Fifty-four of the 71 companies using this concept for lease-or-own decisions use a single calculation.

As a guide on inventory volume and in external and internal pricing. Twenty-eight companies or 22 percent of those replying use return on investment for evaluating inventory size. Only one of the 28 attempts more than one calculation. The calculations used were varied. Return on investment is used by 34 companies in their external pricing. All companies except three use a single calculation and the method of calculation is quite varied. Only fifteen companies use return on investment to guide them in internal (transfer) pricing; twelve of them use a single calculation. Two calculations dominate all others: payback is used by six companies and return on total assets at original cost by the same number. Again, these statistics may be misleading, since we do not have an

indication of the number of companies covered by the survey which have the problem of internal pricing.

Analysis of investments in other companies. There were forty-six companies who apply return on investment to their investments in other enterprises. Thirty-three of them use a single calculation. Return on net worth is used the most often in this type of analysis. Major interest seems to be in the return to owners rather than an evaluation of the management and total profitability of the company.

Other investment bases used in calculating return on investment:

1. Gross investment before depreciation and reserve for bad debts less cash, accounts payable and tangible assets.
2. Economic value—replacement value adjusted in some cases to reflect lower profit potential due to excess operating cost.
3. Fixed assets less depreciation plus inventories.
4. Return on total assets at original cost less cash and marketable securities.
5. Return on total assets at book value less current liabilities and excess cash.

Summary

Modern management has found return-on-investment concept to be an excellent tool to aid in decision-making. Extensive use of this tool is being made in a variety of applications. Although a great deal has been written regarding methods of calculating return on investment, there is no one best method; it depends to a great extent on the application or the problem management is attempting to solve. Discounted cash flow, a relatively new method of calculation, is gaining wide acceptance, especially in evaluating new capital expenditures.

A good single investment base for any company should meet the qualifications listed below:

1. The investment base should be consistent from year to year.
2. The base should be computed in a manner to permit comparisons with outside companies.
3. The investment base should be simple enough to be readily understood and it should avoid complicated allocations which are difficult to explain or justify, as well as difficult to arrive at clerically.

The accuracy of the rate of return arrived at depends primarily on the accuracy of the basic information used in the calculation. Therefore, major emphasis must still be placed on obtaining accurate source information in order for rate of return to be of maximum value in aiding management with decision-making.

Emphasizing Rate of Growth in Rate of Return

by RICHARD A. WARNE

IN THE PAST TEN YEARS, the return-on-investment concept has come into its own, but the formula for return, as usually presented, lacks certain elements. One of these is the flow of time. The question of what rate of return is required over the long pull is not answered by the conventional return-on-investment analysis. Typically, it is assumed that management has decided what rate of return is required. Then the formula is used to explore how this return can be achieved. But the hardest question of all is left unanswered—what should the return on investment be?

The Familiar Formula

The objective of this article is to shed some light on this important question, not to answer it categorically. Through exploration of an algebraic approach to the problem, perhaps a few significant factors will be introduced which will be of help in establishing a return-on-investment goal. To begin with, a review of the return-on-investment analysis as usually calculated will provide a foundation for discussion.

Return on investment is defined as income divided by investment, i.e., income related to the investment required to produce it. Return on investment is also the product of the turnover of investment as measured by sales volume and the profit margin on sales. These relationships, now quite well known, are given here because, in succeeding pages, we are going to use them in a special way. Their mathematical form is as follows:

$$\text{Return} = \text{Turnover} \times \text{Profit margin} = \frac{\text{Sales}}{\text{Investment}} \times \frac{\text{Income}}{\text{Sales}} = \frac{\text{Income}}{\text{Investment}}$$

Recognizing Growth

Each of the compared factors can then be analyzed further to implement decision-making and control. But note that nowhere is there a provision for giving effect to a rate of growth. It is this factor that we wish to introduce into the

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analysis. In short, what rate of return is required to support a given rate of growth? To get at this, we shall assume for the sake of simplicity that investment is stockholder's equity and that income is income after taxes. Thus, the only transactions which affect investment are retained earnings (the difference between income and dividends) and stock transactions. Extraordinary transactions carried through retained earnings rather than through income will be ignored in this discussion.

As a first proposition, growth must be defined. Are we talking about sales growth, growth in investment or income growth? In the long run it makes no difference. Growth of all three factors must be at approximately the same rate or a badly balanced situation must develop. For example, if sales grow at a rate of 10 percent annually and investment increases 5 percent each year, the turnover of investment will constantly increase. There comes a limit at which it can be increased no more. Then the two factors must increase at somewhat the same rate. Much the same is true of sales and income, and income and investment.

It should be stated again that we are concerned with the long-range picture. The purpose is to determine what rate of return is required to support a given growth rate. The conventional return-on-investment analysis can then be used to determine the interplay of turnover and profit margin, to achieve and maintain the required rate of return. In analyzing growth, the simplest situation is that of a firm which pays no dividends and finances all growth internally. Investment at the end of any year for such a firm is equal to opening investment plus income for the year.

Symbolically:

Let: R_n = Return on investment in any year n,
I_n = Investment at the end of year n,
P_n = Income in year n, and
r = rate of growth.

Then: $R_n = \frac{P_n}{I_n}$

Also: $I_n = I_{n-1} + P_n$

That is, investment at the end of the year equals investment at the beginning of the year plus income for the year.

But: $I_n = I_{n-1}(1 + r)$

That is, investment at the end of the year equals investment at the beginning of the year plus growth in investment for the year.

Thus: $I_{n-1}(1+r) = I_{n-1} + P_n$

Solving for P_n:

$$P_n = rI_{n-1} \qquad \text{And: } R_n = \frac{P_n}{I_n} = \frac{rI_{n-1}}{I_{n-1}(1+r)} = \frac{r}{1+r}$$

RATE OF RETURN ON INVESTMENT REQUIRED FOR VARIOUS RATES OF GROWTH ASSUMING NO DIVIDENDS AND NO EXTERNAL STOCK FINANCING

$$R_n = \frac{r}{1+r}$$

Rate of growth r	Return R_n
2%	2.0%
4	3.8
5	4.8
6	5.7
8	7.4
10	9.1
15	13.0
20	16.7

EXHIBIT 1

How is this result used? Exhibit 1 illustrates the return required to support the rate of growth under various assumptions of growth rate. Of what significance is this? Well, it is easier to establish a desired growth rate than it is to attribute significance to a rate of return. The latter may not seem to suggest action one way or another but growth rates give management something tangible on which to establish company policy. Establishing an objective for growth would seem to make more sense than establishing a goal for rate of return and then making a stab at a growth rate which is compatible with the return goal. In addition, growth rates in industry are published statistically and can be projected on such factors as population, income, and the like. To summarize the data presented in Exhibit 1, the higher the projected rate of growth, the higher the requirement for return on investment.

Recognizing Dividend Policy

Analyzing rate of return required to support assumed growth rates is illuminating but it is incomplete. Corporations must also pay dividends and, if our analysis is to prove of any use, it must take cognizance of this fact. When a firm pays dividends, ending stockholders' equity equals net income less dividends plus beginning stockholders' equity. Typically, dividend policy is stated as a percent of net income paid out in dividends. Thus let:

d = percent of net income paid out in dividends.

Then: dP_n = Dividends

And: $I_{n-1}(1-r) = I_{n-1} - P_n - dP_n$

$$P_n = \frac{rI_{n-1}}{1-d} \qquad R_n = \frac{r}{(1-d)(1+r)}$$

Again, as in Exhibit 1, various rates of growth and a varying dividend policy can be considered to determine the rate of return required under the various assumptions. Exhibit 2 illustrates a few possible alternatives.

Again, it would seem easier to determine corporate dividend policy and desired rate of growth than to assume a rate of return and guess at growth and dividend policy. Exhibit 2 also begins to illustrate another aspect of this analysis, i.e., the exclusion of goals which are obviously unattainable. For example, a ten-percent growth rate might be considered reasonable. Likewise, it would seem reasonable to pay out 75 percent of net income in dividends. But this would require a 36.4 percent rate of return on stockholders' equity after taxes. A moment's reflection on competitive pressures, government regulation, and labor union demands quickly indicates that this goal might prove overly ambitious. Even more ludicrous is a goal of a 20 percent growth rate and a dividend policy of 75 percent payout.

One possible solution to this problem is that of company investment expansion through external stock financing. This is dealt with below. But first, as a summary comment on Exhibit 2, it may be said that the higher the rate of growth and the higher the dividend payout, the higher the return on investment required.

RATE OF RETURN ON INVESTMENT FOR VARIOUS RATES OF GROWTH AND DIVIDEND PAYOUT ASSUMING NO EXTERNAL STOCK FINANCING

$$R_n = \frac{r}{(1-d)(1+r)}$$

Rate of growth r	Dividend payout d	Return R_n
5%	25%	6.4%
5	50	9.6
5	75	19.2
10	25	12.1
10	50	18.2
10	75	36.4
20	25	22.2
20	50	33.3
20	75	66.7

EXHIBIT 2

Recognizing the Effect of External Stock Financing

If a company expands rapidly, it will probably find itself in need of an expanded capital. Consequently, it will go to the money market for funds. As the following analysis will illustrate, the greater the percentage of growth which is financed externally, rather than from retained earnings, the lower the rate of return required to finance a given growth rate. Let:

e = percentage of growth to be financed externally.

Since Growth $= rI_{n-1}$

Then: $I_{n-1}(1+r) = I_{n-1} + P_n - dP_n + erI_{n-1}$

This proposition may be stated in words as follows: Ending investment equals beginning investment plus net income minus dividends plus proceeds from sales of stock. Treasury stock transactions have been assumed to be nonexistent for this analysis.

In this case:

$$P_n = \frac{rI_{n-1}(1-e)}{(1-d)} \qquad \text{And:} \qquad R_n = \frac{r(1-e)}{(1-d)(1+r)}$$

Exhibit 3 illustrates alternatives under this formula.

Here again, as in Exhibit 2, certain alternatives are conspicuous by their unreasonableness. A 10-percent rate of growth, combined with a dividend payout rate of 75 percent and external financing of 25 percent, requires a return of

RATE OF RETURN ON INVESTMENT FOR VARIOUS RATES OF GROWTH, DIVIDENT PAYOUT AND EXTERNAL STOCK FINANCING

$$R_n = \frac{r(1-e)}{(1-d)(1+r)}$$

Rate of growth r	Dividend payout d	External finan. e	Return R_n
5%	50%	25%	7.1%
10	50	25	13.7
20	50	25	25.0
5	75	25	14.3
10	75	25	27.4
20	75	25	50.0
5	50	50	4.8
10	50	50	9.1
20	50	50	16.7
5	75	50	9.5
10	75	50	18.2
20	75	50	33.3

EXHIBIT 3

27.4 percent, a very ambitious goal over the long run. Perhaps a more reasonable goal would be the 10-percent growth rate, a 50-percent dividend payout and 25-percent external financing. The extent of external financing would vary with how closely controlled the corporation is (indicating less anticipated external financing) and how often and for how much the corporation wishes to enter the money market.

Excluded Problems

Throughout this discussion, several vital problems have been omitted from consideration. This has been by design to keep the analysis simple. Two of major importance which deserve comment are the problem of fluctuating price levels, particularly inflation, and the possibilities of debt financing. The former should be taken into account in arriving at a desired growth rate. Thus, if it is assumed that a growth rate of 10 percent in real dollars is required and that inflation in the amount of 2 percent each year is present, the growth rate used in the formula should be 12 percent.

The problem of debt financing may also be considered a part of the formula. Earlier in the discussion it was pointed out that investment, sales and income must grow at about the same rate in the long run to avoid an unbalanced situation. The same is true of debt and equity financing. A company cannot continue to finance all of its growth through debt financing out of proportion to internally generated retained earnings or it will find itself in a "thin" position, that is, at a point at which such a large part of its capital structure is debt that additional debt will be difficult to incur.

For an Adequate Return

The purpose of the formulations offered and illustrated in this paper has been to introduce factors of growth, dividend policy and external financing into the return-on-investment computations. The more basic thinking is that a corporation is run for the benefit of its stockholders, that risk is what has produced our dynamic economy and that those taking the money risk must be protected through return on capital and all of its increments. It is felt the relationship of factors presented in Exhibit 3, incorporating the considerations implied in growth statistics, corporate dividend policy and the ability of the corporation to attract equity capital can be applied to protect the stockholder and yet not price the corporation out of the market or lead to short or long-term harmful effects. A generous amount of management judgment must be used also. The factors of turnover and profit margin may then be utilized to more effectively arrive at a method of reaching the return-on-investment goal.

How We Base Product Profit Studies on Return on Employed Capital

by VICTOR SCHMIDT

RETURN ON EMPLOYED CAPITAL is a percentage that measures the ratio of profit secured to investment required. It is entirely comparable with the more familiar return on investment except for accounting terminology in respect to what constitutes the investment base, specified later in this article.

First, why is the return on employed capital measuring stick used? Essentially the reply, while not intended to indicate that this measurement is the answer to all product evaluations problems, is because it reveals the basics of profit contribution in a more complete manner than other measuring devices, i.e., cost, profit on sales, profit per machine hour, etc., can possible accomplish. It is the measuring of turnover that makes return on employed capital more complete than other profit evaluatory techniques. The word is used in many connotations in accounting or financial technical jargon, but the most simple definition that meets the situation under discussion is, "velocity." Without this measurement we tend to ignore the fact that the faster we can convert assets of the business from such unliquid states as plant, machinery, material, inventory, receivables, or the more often we can convert these assets to the liquid form we call cash, the greater will be our return on investment. Simply considering the relationship of return to investment shortcuts this feature. However, the now familiar expanded definition expresses both the return and turnover components:

$$\text{Return on employed capital} = \frac{\text{profit}}{\text{sales}} \times \frac{\text{sales}}{\text{employed capital}}$$

The first component is readily recognized as our most common profit measuring device, percent profit on sales. The second is the element of turnover, here expressed as the number of times that sales "multiply" employed capital. The fact that we can abbreviate the formula should never cause us to lose sight that a return on employed capital percentage can always be obtained by multiplying percent profit on sales by rate of employed capital turnover. This is basic. From it, we begin to appreciate that

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profit contribution is not just a function of percentage on sales, that a low gross profit on sales combined with a high turnover can often surpass the contribution of a high gross profit on sales if the latter's turnover is unfavorable enough. In retail merchandising these principles are never ignored. The average merchant cannot afford to ignore them. In a large diversified manufacturing enterprise, we tend to forget them because of our specialization of tasks. A sales manager has the responsibility for two important elements affecting the formula, price and volume, but he is not held accountable for the other two, cost and capital. Those are in the province of manufacturing. Unfortunately, turnover, which is volume related to capital, suffers in attention from divided responsibility.

Allocations of Capital to Products

In our presentation employed capital consists at present of:

1. Plant and machinery, including budgeted shares of capital tied up in services such as utilities, maintenance and plant administration.
2. Inventories of raw material, work-in-process, and finished goods in amounts based on average experience.
3. Accounts receivable valued at actual selling prices aged on average experience.

How we relate cost to capital, as a step in determining product rate of return is both analogous and related to the development of machine hour charging rates for costing purposes. By this method the accountant collects, first, the budgeted variable cost directly associated with the machine center and then the fixed budgeted amounts for expenses, both those directly associated with the operation, and those to be absorbed by all operations. He expresses his total of costs as the function of the number of hours the machine is budgeted to run.

Employed capital charging rate for physical assets values is developed in much the same way. The capital figure for production equipment is known. The capital invested in the land and buildings is allocated to the equipment, generally on a square-foot-of-occupancy basis. Capital invested in services, such as utilities and maintenance, is assigned to productive operation on the same basis as the machines are budgeted to use the service. Finally, capital invested in plant staff office space and facilities is allocated to the machine center upon a basis consistent with the method used to distribute the budgeted expenses involved in the particular staff departments to machines. After the analyst has thus collected the total plant and property capital dollars to the production center, the amount is divided by the budgeted hours of operation to arrive at an employed capital charging rate per machine hour. Once developed it is

a simple task to apply the charging rates to a product for which the cost of manufacture has been calculated. Every operation is "capitalized" by multiplying the hours of charged machine time required at each processing stage by its employed capital charging rate.

The assignment of employed capital values to products for inventories and accounts receivable is quite straightforward. A determination of average aging must be made; once determined the inventory or receivable age is related to the period of a year in terms of percent. For instance, assume that past experience dictated the wisdom of using two weeks as the average age of all inventories and accounts receivables. Two weeks related to fifty-two weeks equals 3.85 percent. This is applied to appropriate bases. For raw materials employed capital, the analyst may calculate 3.85 percent of the raw material cost, for in-process and finished goods 3.85 percent of the total cost, for accounts receivable 3.85 percent of the selling price minus discounts. In actual practice, ages of each element will vary and the percentage applied to reach an answer for each and as applied to products will not be quite as simple as this explanation might be taken to indicate.

Return Analyses Developed

Product profit analyses using return on employed capital are prepared in response to requests from:

1. The marketing department for use in evaluating product prices.
2. The manufacturing department to evaluate manufacturing method, material or process alternatives.

Since we evaluate prices for finished or completed products upon the basis of producing cost plus transferred manufactured materials at market prices, studies prepared for the marketing department customarily emphasize the return on employed capital in conversion. Gross profit from converting is related to employed capital in this process and prices are recommended for the consideration of a sales manager upon the same basis as exists for competitors who must buy their materials in the open market.

This is not to say that the aspect of profit on manufactured materials or return on employed capital for the entire manufacturing process is neglected. For evaluation of two or more process alternatives for the same product, because use of market price for manufactured materials does not compare materials fairly for this purpose, most of those types of analysis will use product costs which value transferred manufactured materials at company-wide costs to produce. By using cost and employed capital for all prior manufacturing stages, the end product can be evaluated without the sometimes distorting influence from irregu-

larities in market prices for manufactured materials in it. And, since almost every process alternative ultimately must come to a conclusion in the form of a marketing pricing decision, we can eventually prepare our studies both ways, one with material at market showing the return on converting employed capital, the other with material at cost showing the return on company employed capital.

In making the employed capital calculations for product or process alternatives, an attempt is made to prepare each so that the basis of comparison between choices is consistent. At the present time, differences between plants, age of equipment, and methods used to acquire assets complicate the picture. Where these may tend to distort the answers reported, the results are so qualified.

Alternative Asset Bases for Return-on-Capital-Employed Computations

by ERNEST U. WIDMER*

MANY DIFFERENCES exist in practices for determining the dollar value for capital in computing return-on-capital-employed ratios. There are persuasive reasons for the differences in most cases. The use made of the return ratio is all important in this decision.

Fixed Assets

Fixed assets are always included. However, the variety here is in the basis on which they are stated. Three kinds of "bases" are used rather widely for the fixed assets. These are:

1. Cost less depreciation reserves, or net capital.
2. Original cost, or initial capital.
3. Replacement value.

Average net capital is also used as a base. The following passages set commonly recognized advantages and disadvantages of these alternatives side by side.

COST LESS DEPRECIATION RESERVES

Advantages

1. Management prefers using the net figure because the dollars for it do appear on the financial statements and use of net amount produces the best looking ratio. (Most will admit that the use of net fixed assets understates total capital.)
2. The use of the net figure avoids the duplication of values, because reserve dollars are reflected in other assets.
3. The amount paid for a fixed asset should be regarded as a prepaid cost and charged over the years during which production is expected. Hence a declining balance should

Disadvantages

1. The use of the net figure produces distortions that make the resulting ratios useless for management guidance.
2. Net fixed assets do not serve well as bases for ratios to be used to compare one period with another.
3. Using net fixed assets in the base leads to many procedural complications which bring challenges by those who prefer another method when the results are under discussion.
4. The net figure does not provide for the replacement of assets in any pricing formula which may be developed from return-on-investment computations.

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be used for statements of capital assets.

4. If depreciation is not excluded from the asset base, it is necessary to make cost and profit adjustments in determining the return ratio, due to the effect of the varying ages of the fixed assets.
5. The net asset figure gives a better answer at company level because the depreciation recovered in sales is reflected in current assets or in other fixed assets. (See also Item 2 above.)

ORIGINAL COST

Advantages

1. Original cost is closer to replacement value than cost less depreciation.
2. It reflects a mixture of like items purchased at different times and, thereby, equalizes facility values in the return ratios developed for units or products of a company. (Personally, I argue with this because the results are left to chance.)
3. The original cost method is very useful in comparing one period with another.
4. At original costs, the assets of one plant may be compared with assets of another plant with different depreciation procedures.
5. Original costs should be used since fixed assets are to be used to produce income during their entire life, i.e., their full cost should be used in the computation of the ratio

Disadvantages

1. Original cost "mixtures" can cause substantial differences in the results of departments or units.
2. If original costs are used to underlie return on capital for pricing, no funds are provided for the higher cost of replacing assets. Original or book costs are useful only in estimating future costs.

until they are retired. The reserve should be looked upon only as provision to protect the original investment.

REPLACEMENT VALUE

Advantages

1. The use of fixed assets at current replacement cost is necessary to develop prices which will provide funds for replacing the assets. Computations based on these higher figures are needed to avoid the bankrupting effect of attrition brought on by inflation.
2. Management is given a more realistic figure for judging the results better under today's economic climate if the return ratio developed is based on replacement costs.

Disadvantages

1. An overstatement occurs. For this reason, original costs are better to use because fixed assets are replaced on a rotation basis and the new assets at current prices bring the average of the original costs closer to replacement costs.
2. Replacement value should not be used because operating costs on older facilities generally are higher and they produce less than the new equipment, thus equalizing costs. In this connection there are probably cases of adjusting production costs on old equipment. Such adjustments are usually difficult because operating efficiency, maintenance and depreciation must be considered.
3. Replacement value overstates capital in relation to costs which are reflected in the profits.

Current Assets

Let us step over to the current asset portion of the base for return-on-capital-employed calculations. Difference in the practice of valuing the current assets included in capital employed are less marked.

Gross accounts receivable at book dollars are used and, if apportioned to company units, this is ordinarily on the basis of sales. When appropriate, adjustments are made for special credit term amounts. Market values or standard costs are mostly used for inventories instead of the "lifo" values applied in many published financial statements. The amounts are then apportioned to units on average usage figures or on the basis of processed items. Cash is sometimes adjusted downward to exclude amounts on hand in anticipation of major expan-

sion or other extraneous purpose. Very often, however, all cash is included in total assets so that its penalizing effect (in lowering the return ratio) will result in special efforts to put it to work in producing profits.

. . . And Liabilities

We come now to the question of deducting current liabilities from the fixed and current assets to arrive at capital employed. The majority opinion is that the deduction of current liabilities destroys the effectiveness of the ratio as a measurement of profit because all assets, regardless of source, should be used with equal effectiveness in promoting profitability of operations.

Applications Must Consider Circumstances

The views presented on capital base alternatives are broad in character. Specific decisions as to the base to use should be made with the understanding of what is implied by the capital amount used. The allocation of the base to company units or departments must be tailor-made. There is no one basis of allocation for each asset which is proper every time.

For meaningful trends the base should be developed consistently. When the total assets fluctuate during the year, due to seasonal ups and downs, it is more reliable to use average assets than end of year assets. This is important for units below the company level because managers will play for the best score. If they know the assets on a given date will be used, they will try to see that the assets charged to their unit will be at the lowest point on that date. The result would be a false picture and one which would likely be costly to the company.

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EDITORIAL NOTE

Extreme current and continuing interest centers around the topic of return on investment. The favorable reception accorded N.A.A. Research Report No. 35, "Return on Capital as a Guide to Managerial Decisions," dated December 1, 1959, underscores this interest, as evidenced not only on the part of N.A.A. members but also by calls for copies of the report from general accounting, business and educational circles.

The contents of this issue of Section 1 of the *Bulletin* represents one more facet of this interest, a group of articles which illustrate, among other things, that return on investment stands out prominently as a topic to which N.A.A. authors are addressing themselves. These articles are presented here with the thought, basic to N.A.A. publications policy, that a concern on the part of authors reflects a concern on the part of the membership as a whole.

The use of return on investment which receives major attention in these articles is one to which a portion of the research report was also addressed, i.e., use of rate of return to evaluate or rank capital outlay proposals, nor will it be missed that the discounted-cash-flow method of application is emphasized by a number of authors. However, it will be noted also that one article reports upon a survey of extent of use of return-on-investment information by application and type of calculation and that others deal with special matters related to determination and employment of the return.

Individually authored and reflecting some directions of current thinking, the articles in this issue are neither wholly similar nor wholly dissimilar. Several "lessons" recur, perhaps beneficially, inasmuch as newer concepts make their impress by repeated definition and illustration. On the other hand, each author approaches and treats the topic somewhat differently as to background assumptions and matters which he especially wishes to explain and illustrate.

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